National Seminar on Value Added Dairy Products
(DECEMBER 21-22, 2005)

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From the President’s Desk

Dairy Technology Society of India and National Dairy Research Institute are honoured to host the First Conference of Dairy Processing on Value Added Dairy Products in Karnal, the city of Dan Veer Karna, from December 21-22, 2005. First of all I would like to take this opportunity to extend you all a very cordial welcome to this national conference on my behalf and on behalf of the Organizing Committee.

I feel pleased and proud to announce that Dairy Technology Society of India has been contributed on May 31, 2005 at NDRI, Karnal. The basic objective of this society is to provide a forum for the scientific discussion and exchange of ideas in the field of Dairy Processing and to generate a sense of brotherhood and fellow feeling among the dairy professionals. The society has been constituted with national mandate at the prestigious National Dairy Research Institute, Karnal.

The contribution of NDRI is well reorganized nationally and internationally in the field of dairying. Its pioneering work in generating quality human resource and undertaking need based research helped in ushering white revolution in the country. Thus, this Institute richly deserves to be the headquarter of this vibrant society.

Dairying is an instrument for change in the social and economic status of people in the country like India. Over the last about four decades, there has been tremendous changes in the dairy sector of this country. India now occupies 1st position in milk production in the world. In the process of attaining this distinction the Dairy Technologists of the country have played a monumental role. In this age of liberalization and globalization, there will be renewed focus on product diversification, value addition, quality improvement and export promotion which will define a more challenging role for the professionals engaged in the pursuit of Dairy Technology and allied sciences.

Dairy Technology is the industrial non-farm phase of the tremendously large, dynamic and complex Dairy Industry. This phase represents a combination of Dairy Chemistry, Dairy Microbiology, Dairy Engineering, Dairy Business and art as applied to all dairy-type foods and their industries. Dairy and dairy-type foods represent a major segment of the vast and varied Food Industry.

Food Processing industry is of enormous importance for the development of our country because of the central linkages and synergies that it promotes between the two pillars of our economy, agriculture and industry. Fast growth in the food processing sector and progressive improvement in value addition is also of great significance for achieving favorable terms of trade for Indian agriculture both in the domestic and overseas markets.

Success in various developmental plans by various states and national agencies over the past about four decades have resulted in the modernization and building up a vibrant dairy industry in India. This has been possible due to the relentless efforts of the dairy farmers, scientists, professional managers, policy makers, visionary leaders and national institutions. As a result well defined infrastructure has been created which would accelerate further growth in future. Availability of large number of milch animals and milk at the competitive prices provides India certain strategic advantages globally. With the liberalization of economy and
access to better prices in world market newer opportunities would be emerging in the immediate future. Though we have occupied 1st position in milk production in the world, but our contribution to world trade is negligible. This can be accomplished by value addition and product diversification.

The milk is considered nature’s almost perfect food. By the same token, it provides an ideal medium for the growth of microorganisms. As a result, its shelf life is very short, 5-6 hrs at ambient temperature. The first and most important stage of value addition takes place by application of heat, i.e. pasteurization when the shelf life can be enhanced up to two weeks under refrigeration. The second stage of value addition takes place when higher heat treatment, viz. sterilization and UHT processes are applied. Thus the shelf life can be enhanced up to months at ambient conditions. These two processes also provide an avenue for producing variety of fluid milk products, viz. full cream milk, standardized milk, toned milk, double toned milk, variety of flavoured milk and beverages, sterilized and UHT milk etc. The third stage of value addition occurs when precious milk is covered into an array of mouth-watering dairy products. The value addition does not end here. The milk and milk products provide an ideal medium for the enhancement of functional nutritional, therapeutic and medicinal value of milk and milk products.

The demand for the value added foods is being driven by the growing public understanding of the linkage between diet & health, and the interest in self-health maintenance, rising healthcare costs and advances in food technology and nutrition. Growing health consciousness and awareness for healthy nutrition have increased consumer demand for foods of superior health quality. Increasingly, medical and nutritional researchers have been linking food components to disease prevention and health enhancement. Due to the today’s upward consumer awareness and interest to follow healthy nutrition and dietary strategy in achieving health benefits from foods beyond their basic nutrition, the market for value added foods has expanded manifolds. Today’s consumers are increasingly seeking functional foods for their health and well being as means of nutritional intervention in disease prevention. Dairy products enriched with the health attributes of functional ingredients would be safe and viewed as potential novel foods for health promotion in the next few years. However, the level of health claim with optimum sensory and textural properties of such foods has yet to be investigated.

For people who want to reduce their own risks of heart disease, choosing a dairy spread or dahi, etc enriched with specific functional ingredients would make sense. The traditional dairy products fortified with probiotics, prebiotics, buttermilk solids, plant sterols and stanols, dietary fibers, fruits, bioactive peptides, -3 and -6 PUFA, natural antioxidants, etc would provide an additive effect on top of their medication when used regularly as part of regular diet. The future viability and success of value added dairy products in the marketplace depend on several elements. The key issue is of consumer acceptance of such products. For consumers to agree and pay the premium associated with value added foods, they must be convinced that their health claim messages are clear, truthful and unambiguous. Stimulation by government authorities to change legislation and approval procedures, encouraging involvements in the research, and gaining consumer credibility will foster more accepting commercial atmosphere for the development of introduction of such foods in the
market place. It is evident that value added dairy foods will be seen in many different markets beyond what is known today. India is emerging as a mega dairy market of the 21st century. The recent liberalization has thrown a bagful of opportunities for dairy entrepreneurs to manufacture our traditional dairy products on industrial scale, which upon value addition and stringent quality assurance programme would possibly compete in the International food markets with the branded functional foods, now being seen in the shelves of supermarkets.

India is the only country, which is bestowed with lot of biodiversity. We have all kinds of milch animals with significant amount of milk production, notables being buffaloes, cows and goats. The physico-chemical properties of buffalo, cow and goat milks differ significantly. This offers an unique opportunity for producing variety of specialty products to meet all kinds of situations. For example, our country is the highest producer of buffalo milk in the world. Buffalo milk is specially suited for producing certain dairy products, viz. Mozzarella cheese, Feta cheese, Domiati cheese, Paneer, khoa and ghee, etc. India can capitalize on certain virtues of buffalo milk and become a center for supplying special value added products all over the world. Pizza has become an international dish for which Mozzarella cheese is an essential ingredient. Middle east provides an enormous scope for specialty dairy products.

I am sure the deliberations of this seminar will go a long way in promoting value added dairy products and developing a shared view which would provide a future road map for the policy makers, scientists, managers, entrepreneurs and dairy farmers to ensure all round development of Dairy Industry in the country.

Lastly, I once again extend you all a very warm welcome and hope that your stay will be comfortable, enjoyable and memorable one.

Dr. S. Singh
President
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Wishes its Members and Delegates

A Very Happy New Year 2006
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Value Addition in Dairy Industry – Vision 2020

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Dairy Industry in India

The dairy industry in India is considered to be a category, which has been growing and profitable. This category is better organized amongst other categories of processed food industry in India. When the world production of fluid milk stands at around 613 million tonnes and is growing at a rate of only 1.1 percent India’s milk production stood at 91 million tonnes growing at around 4 per cent per annum. This means that 15 % of the world’s milk is produced in India and that too growing at a rate four times of global growth rate giving India the status of the largest milk producing nation in the world. There are two differences, namely, about 58 percent of this milk is from buffalo and despite being the highest milk producing nation in the world the per capita milk consumption in India is still lower (229 gm per day) than the world average (285 gm per day). Our milk production, processing and marketing channel as it exists is unique in nature. About 70 million rural households are involved in cattle rearing and milk production, out of which only 11 million farmers are linked with the 0.1 million dairy cooperative societies generating about 18 million tonnes of the fluid milk daily. This milk from dairy cooperatives forms the major source of fluid milk supply to cities and towns across the country.

Out of 91 million tonnes of fluid milk produced in the country rural consumption is about 39 million tonnes (45 percent of the total) and another 17 million tonnes (20% of the total) also consumed as fluid milk supplied to urban areas from the nearby villages. Thus 65 % of the total milk produced in the country is consumed as unprocessed fluid milk. The balance 35 % is processed into the value added products of which unorganized sector utilizes about 24% or 22 million tonnes of milk. As unorganized sector utilizes lower level of technology and also low quality control measures, value addition in those are not much. And in the organized sector the remaining 11 % or only 10 million tonnes of fluid milk really goes for processing, out of which about 6 million tonnes is utilized as packaged fluid milk like UHT milk and only 4 million tonnes is processed by the organized sector for real value added dairy products. About 50 per cent of the total milk production is consumed by the urban population either as fluid milk or as value added processed milk products.

The operation flood programme initiated in 1970 and the cooperative movement helped us to reach this stage. The cooperative sector over the years have created many successful brands including Amul, which is a leading dairy brand with all India presence. Others, which are also well known but has a very strong regional presence are Aarey in Maharastra, Verka in Punjab, Nandini in Karnataka, Vijaya in Andhra Pradesh, Saras in Rajasthan, Mother Dairy in Delhi and Kolkata. Out of all these, Mother Dairy has now graduated to a level that they can claim an all India presence now in addition to AMUL, which has an advantage of scale and cost. AMUL has emerged as the largest food industry in India, which was possible because of its inherent character of low cost and easy and assured access to the raw material.

It should be noted that large part of the production of milk has to go for direct consumption as fluid milk and we still have milk shortage areas to feed. Primary task is therefore, to ensure safe and hygienically packed fluid milk that retains the quality and standard to reach the uncovered rural and milk deficient areas. In this process, we can add some value through standardization, packaging, distribution and supply chain management and also through the brand building exercise. The major value addition possibilities has to be seen in the context of surplus milk available for processing by the organized sector and
also helping the unorganized sector to go up in the value chain. The task is therefore, multifaceted.

**Market for Value added dairy products**

Flavored milk is increasingly becoming popular in the certain market. As consumers are getting more health conscious there is a growing tendency to buy health foods in place of other forms of beverages. Flavored milk thus constitute a good substitute for carbonated soft beverages and significant value addition is possible either through packaging or through the innovative formulation. For example, flavored milk can be both synthetically flavored as well as can be mixed with real fruit juice and pulp. Although the base is still small, the flavored milk market is said to be increasing by around 27 per cent in value terms. There are host of brands mostly regional are being sold in this segment. Additionally, Nestle's Fruit & Milk and Amrit Foods Gagan are quite popular in the northern region. In the recent times, we are witnessing lot of activities in the dairy segment and there are products in this segment, which are actually diet milk, fortified milk. Both Amrit Foods and Nestle have launched low fat milk with less than 0.5 % fat recommended for people with high cholesterol and blood pressure. There are number of brands in the UHT milk segment in tetra pack and the volume in this segment is said to be about 70 million liters and growing at a rate of about 20% per annum in volume terms.

Both plain and flavoured yoghurt (Dahi) including misti dahi are now selling in volume and we have Amul, Mother Dairy and a host of local brands in the game. Fruit yoghurt and stirred yoghurt are yet to gain a meaningful volume. Earlier attempts in this direction have failed and the current market is largely for the set yoghurt. But there are number of curd based products now in the market such as lassi, butter milk, chhas etc. which were earlier the domain of the unorganized sectors served through local shops and made to order but now being introduced by both cooperatives dairies and private players. Other traditional products such as paneer, khoa and khoa-based sweets are actually the strong hold of small and unorganized players. Amul has introduced paneer in the market, otherwise all are the local and traditional players. There is lot of opportunity for this segment to go up in the value chain to help the dairy segment to deliver higher value.

We did not have good quality cheese earlier. Only Amul was selling processed cheese and cheese consumption was nothing much to mention about. Of late, this segment has grown and has become Rs 450 crores in size and processed cheese is still the leading contributing about 60 % of the total category and growing at a rate of 15% annually. Additionally, we have cheese spread and mozzarella, which goes mostly in pizza topping. Britannia has influenced the growth in the cheese market introducing cheese from cow milk. Dabon International’s brand Le Bon also has captured significant market in this category. Earlier we had only Amul cheese cubes wrapped in foil and packed in containers but now we have cubes, slices, spreads etc. fuelling the growth of this segment so much so that Laughing cow, a foreign brand also sells in leading urban outlets.

The market for dairy whiteners, creamers and condensed milk has been reported to be to be about 200 MT valued at Rs300 crores. The products are available both in pouches, tins and as well as in tetra packs. In this segment also we have regional players such as Vijaya, Parag and Sapan and all India players such as Amul, Nestle.

The ice cream market is estimated to be about Rs 1500 crores of which organized sector contributes about Rs 900 crores (equivalent to 40 million liters). Amul is the leading player controlling about 28% of the total market, Hindusthan Lever has 8% and Vadilal and Mother Dairy has about 7% share each. The share of the unorganized sector is gradually shrinking.
The other dairy products include butter, ghee and milk powder. Of which, milk powder which is a Rs 25500 crores category is entirely with the organized sector. But in butter and ghee unorganized sector is the larger player. Butter is a Rs 6500 crores category of which organized sector represents only about Rs 500 crores and ghee is Rs 24500 crores of which organized sector is only Rs 3500 crores and the balance is with the unorganized sector. Small local brands have been able to create a niche and competing on price equation.

**Value Addition in Dairy Products**

In last one decade the processing scenario has changed. There are more players in the segment both Indian and overseas than before. Some of the private players and their brands also disappeared during this time as they could not play the new rules of the game. Local new players are not able to play the high pitch marketing game and therefore gradually reduced to become the subcontract manufacturers for the large players. Both Dabon International and Britannia are therefore, marketing the brands of cheese sourcing from Indian local players. In the cooperative sector Amul has overshadowed other state cooperatives. They have their success stories but not been able to grow beyond the regional level.

The large part of the processed dairy products are still with the unorganized local and small players including halwais and dudhias who operate in small pockets using traditional methods of processing where large players cannot easily reach. The task in hand is thus how we can integrate those unorganized players to upgrade them in the value chain? Can we help them to produce using better technology maintaining quality standard so that large organized players can market those at higher value through a franchised chain of outlets spread all over which can be owned by the same unorganized players so that they get higher value and at the same time play a larger role in the national interest? This is both technology as well logistic management task and we need to create a model for the success.

**Future Vision 2020**

India would like to emerge as the leading economic power by year 2020. According to the prediction of Goldman Sachs, India will become one of the three, along with China and America, leading economic super power by the year 2050 but we would like to achieve that status by 2020. In the next five years we will be delivering the same economic growth which we could achieve in last fifty years. This is possible if we grow at 7-8% in GDP terms year on year as projected. And if that is to happen agricultural sector has to deliver about 4% growth year on year. Given a good rainfall this should be possible. Although, a pessimist will argue that in post liberalization, agricultural growth rate has reduced, it was 3-4% before 1990s but in the first three years of the 10th plan period (2002-2007) agricultural sector growth plummeted to near about 1% but the economy has the resilience to absorb that pressure and we still delivered the growth rate supported by the service sector. We need now another successful green revolution focusing on horticulture, floriculture and dairy sectors. By year 2020 our domestic demand for milk and milk products likely to reach a level of about 170 million tonnes and we can achieve this target provided we continue to maintain the current level of growth. In the global trade we have the products like butter & milk fat, cheese, condensed milk, whey casein etc. When paneer industry is organized and the volume picks up whey protein isolate, milk lactose will be produced and exported. Our products are based on buffalo milk whereas in global trade cow milk products are traded. Our surplus can be marketed globally in the processed form provided we can develop the market for those. For this purpose we need to forge global level collaboration. But the way market is developing for health related products including milk we will not have any difficulty in finding market for the increased milk output as projected in the domestic market itself. Currently, India’s
share of global trade is less than 1 per cent despite being the largest producer. We still have low milk yield per animal coupled with our inability to create brands in the global market, which makes our task in the global trade more difficult. But I can foresee that Indian players have to play a role in future in the global market by forging alliance with global players.

The domestic consumption for milk products will grow heavily. For example, it is projected that Cheese market in India will grow from the current level of Rs 450 crores to about Rs 1100 crores by the year 2015. Dairy whiteners market is projected to go up from 200 MT currently to 300 MT during next five years. Value added fermented milk products are already in the market. We will see the introduction of many nutraceutical beverages based on milk and fermented milk in the coming years.

The significant value addition to the products is possible only through aggressive marketing and brand building exercise, which require both resources and skill. Global market will be competitive and our players have to create and capture value at all level of interfaces starting from the procurement. Cooperation and competition and integrated supply chain management will be the key if Indian dairy sector has to play its legitimate role to deliver higher value and take its products and merchandise all over.
New Product Development in Dairy Sector: Spotting Opportunities

DR. L. K. VASWANI  
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Introduction

India has achieved spectacular growth in milk production to reach a level of 91 million tonnes and is still growing at CAGR of 4 percent. However, one of the important concerns for the future will be discovering way and means to expand the demand to absorb incremental production. This will require far more greater effort in promoting consumption in the domestic market and highly competitive export markets. This is going to be the single most important challenge which needs to be addressed to achieve healthy growth of dairy industry in future. Given the high self-indulgence of Indian population with milk and milk consumption, demand expansion should not pose much of a problem provided domestic markets are tapped with greater understanding of consumers and changing consumption environment which is shaping changes in consumer preferences. So far the dairy industry has been slow to react to these changing consumption trends. This lack of effort is reflected in nearly stagnant share of organised sector (approx 13 per cent) over the years as against 42 per cent market share commanded by the unorganized sector. The remaining 45 per cent of production is consumed in the rural areas itself. One of the important reasons for this stagnation is the restricted product portfolio of the organized sector - packaged milk (8 per cent) and dominantly western milk products (5 per cent). On the other hand the unorganized sector has much wider portfolio of indigenous products (23 per cent value added products) with greater alignment with consumer preferences and ability to cater to regional product preferences in addition to larger share of liquid milk market (19 per cent). In fact, the organized dairy sector has not done much in terms of investments in research and development of innovative dairy products. The product portfolio of the Indian dairy industry has hardly shown any departure from its traditional product base. The exception being consolidation of ice-cream market and some fragmented efforts in promotion of traditional milk products like Curd, Shrikhand, Gulabjamun and Buttermilk in last few years. The inadequacy of these efforts has resulted in widening gap between milk production and sale of milk and milk products. A recent report has indicated that during the year 2004-05, dairy cooperatives procured 15 percent more milk than 2003-04, but milk marketing rose just by 5 per cent. This trend may gain momentum, if the Indian dairy industry fails to catalyse the consumption of milk and milk products in the changing consumption environment driven by greater concerns for health and wellness. It is time the Indian dairy industry places far greater importance in developing and launching more successful milk and milk based products which in turn will help to increase demand for dairy products and absorb increasing marketable surplus of milk.

New Product Development – Opportunities Framework

A closer examination of new product development process in developed and developing countries with substantial milk production leads to identification of factors which are critical to develop and launch successful milk and milk products. When these factors are further viewed and integrated in the Indian context, interesting opportunities seem to emerge with regard to development of new products (Fig.1).

The above framework suggests that significant investments will be required in understanding consumer behaviour and preferences; new product research and development; technology development and its management and commercialisation of new products in the marketplace. The framework also brings out the fact that innovative development of products
is governed by number of complex factors and it will be necessary to understand these factors with particular reference to dairy industry in India.

**Understanding Consumer Behaviour**

The professionals engaged in the dairy sector are of the view that milk is the most wholesome single food available in nature but that may not be the consumer viewpoint across the country. As indicated above, the consumer behaviour is an outcome of interaction between consumer needs (health, nutrition and balanced diet) beliefs (usage vs. non-usage, dos and don’ts of usage) and concerns (quality, safety, impact of long term consumption, etc). There is a need to generate and disseminate scientific proof to create more favourable impressions on consumers, negate their unscientific beliefs and address genuine concerns with regard to consumption of milk and milk products. There is also need for a unified efforts at the level of industry to communicate the right consumer message on dairy products to enable this product category to compete with other food and beverages.

**New Product Research and Development**

The milk based beverages are known to provide superior nutrition and are a source of high quality proteins, calcium, potassium and other nutrients. The fat in milk can also be a natural source of conjugated linoleic acid (CLA), which may offer multiple health benefits. The milk products also provide an excellent source for delivering pro-biotics, which may play an important role in intestinal health, immunity and other health problems. The ultrafiltered (UF) milk beverages such as lower carbohydrates / higher-protein drinks can suit modern lifestyles. Milk has unique ability to serve as medium for delivery of other nutrients. With these known product advantages, the investments in research and development by the dairy industry need to be stepped up for developing new products with added value and greater ‘differentiation’ to meet the diversified needs of the consumers. In fact these new products should provide ‘effective solutions’ to generic health problems, functional food needs and immunity against health ailments and, above all, should qualify the ultimate test of taste.

Similarly, extensive research and development is required to study the molecular level of various physio-chemical changes that are responsible for imparting the desired body, flavour, and texture attributes to traditional dairy products. The areas of research in traditional
products should include process and design optimization, improvement in shelf-life without impairing the organoleptic quality, packaging and use of functional additives like emulsifiers and stabilizers in reducing the cost of these products. In a nutshell, the product research and development both in traditional and new products should enable the dairy industry to introduce products which can be positioned in the marketplace on different platforms such as taste, health, functionality and nutraceutical properties (Fig.1).

Technology

Needless to emphasise that the new product research and development effort must be backed by appropriate manufacturing and packaging technology. We are aware that the technology and machinery are available for large scale manufacture of western products, but the same is not the case with regard to traditional products. The major problem in promoting traditional products is the availability of technology for their large scale manufacture and also maintaining foods safety standards.

The ethnic products are mainly prepared from three intermediate products namely Khoa (partially heat desiccated milk), Chhanna (Coagulated milk after draining of whey) and Chakka (concentrated curd) and are generally manufactured with traditional technology. The organized dairy industry needs to acquire expertise to apply HACCP to improve the safety of these intermediate products in addition to standardization of technology for their large scale manufacture. Some efforts seem to have been made in this regard, but there is a lack of information/documentation regarding wide scale success in adoption of these technologies for manufacture of traditional products. However, entrepreneurial efforts have succeeded in branding of these traditional products which goes on to prove that market success of traditional products will not only require technology adoption but will also need a new business model to enable the entry of organized sector into this large market segment.

Commercialisation

The commercialization aspects of new product introductions or existing products have not been adequately emphasized in the Indian marketplace. The consumer acceptance of new products does not occur overnight but it requires a sustained effort to maintain quality, convenience through easy to handle packages and above all crossing consumer affordability barriers to generate economies of scale. The requirement for convenience and quality will grow with increasing disposable incomes and consumer consciousness for health and balanced diet. However, affordability will remain a critical factor influencing consumption for a large section of Indian consumers in smaller cities, towns and rural areas. These constraints/requirements of the target market will require the dairy industry to respond through appropriate interventions in the areas of quality control, innovative packaging and cost management to keep price affordable to their target markets.

Strategic Options

A critical analysis integrating critical growth drivers as described in the NPD-opportunity framework has helped to discover three options for the organized dairy industry in India. If implemented, these options have the potential to radically expand the presence of the dairy products in the food and beverage category and substantially alter its market share compared to unorganized sector. These options are:

Introduction of New Liquid Milk Products

It will be safe to predict that the consumption of normal milk will continue to grow in near future. However, in order to sustain the demand for milk in metro-markets and other
big cities, the dairy industry will have to take initiatives in launching new liquid milk beverages to respond to possible fragmentation of existing consumer segments and to effectively compete with non-dairy beverages. This will require introduction of new liquid milk products through greater product differentiation to service various emerging market segments by the principal benefits sought. The possible product range may include milk products on health and functionality platform, namely flavoured milk, sports and energy drinks including whey drinks, milk plus juice drink, enriched milk (with calcium), pro-biotic milk and lactose/fat free milk.

The Indian market is not yet ready for 'nutraceutical' liquid milk products but product research and development must continue for gradual launch of these products by year 2010.

**New Business Model for Traditional Products**

The Khoa, Chhanna and Chakka are intermediate products for manufacture of most of the ethnic products. A very large part of country's milk production is converted into these products but the organized dairy industry has not taken adequate initiatives to be a part of this huge market. Two major interventions are required to integrate the organized dairy sector to become an integral part of supply chain for traditional milk products. Firstly, the organized dairy sector undertakes the manufacture of intermediate products on a large scale to supply to the unorganized sector for conversion into variety of ethnic products as per regional preferences of the consumers. Such reconfiguration of the supply chain will not only require introduction of technology for their large scale manufacture but also a second intervention in terms of a business model to expand the demand of traditional products in future and upscale their quality standards.

**Launch of Innovative Health Based Dairy Products**

The next generation of value added dairy products must meet the emerging needs of consumers and simultaneously address to their concerns and beliefs. 'Health' and 'functional' foods are going to be the mega-trends of the future in dairy products beginning with metro-markets and gradually spreading to other big cities and towns. The products in the health category would include products for weight management, sports nutrition, fun products providing low calorie, high protein or calcium for today's health conscious customers. The functional product category would include pro-biotic, reduced-fat/carbohydrate and enriched milk products. As indicated earlier, the Indian market is not yet ready for the products in the nutraceutical category which includes therapeutic and dietary products but demand for these products is likely to pick up by the year 2010 and Indian dairy industry must prepare itself to respond to the demand of these high value added dairy products.

**Summary**

With a few exceptions, the Indian dairy industry has been slow to adopt or react to the developments taking place in the consumption environment while the milk production is on the rise. The single most challenge in the near future therefore would be to expand the domestic market as well as gear up to compete in the export markets. This paper focuses on NPD in the context of this imminent future challenge. The NPD opportunity framework suggests that in order to launch new products in the Indian market, significant investments will be required in understanding consumer behaviour and preferences; new product research and development; technology development and its management and commercialization of new products in the marketplace. The paper identifies three strategic options - launch of new liquid milk products, integration of organized dairy sector in the traditional products supply chain and launch of health based milk products as possible ways of upscaling the Indian organized dairy industry and to effectively compete with other food and beverage products.
Export Promotion Strategies for Dairy Products

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India has emerged as the highest milk producing country in the world with an estimated production of 95.4 million tonnes in 2005 that is much ahead than the United States of America that is the second largest milk producer with 79 million tonnes (Figure 1). It is also interesting to note that Russian Federation with 32 million tonnes of milk production remained at third position indicating a wide gap from the highest milk producing country, India. ‘Operation Flood’ Programme that began in 1970s has been the major success stories of any massive programme in the developing world.

Source: Food and Agriculture Organisation (FAO)

India’s milk output continuous to grow annually by about 5% compared to about 2.8% growth in global milk output in 2005. India accounts for about half of the total milk output of Asia confirming its position as world’s largest single milk producing country. However, it is also interesting to note that the milk production in India has consistently increased from 55.7 million tonnes in 1991-92 to an estimated 91 million tonnes in 2004-05 (figure 2). Buffalo milk accounts for 55% of total milk production in India. Only 13% of India’s milk production is collected and processed in the organised sector. The huge balance of 87% is consumed locally and marketed through unorganised sector in thousands of Indian villages. It reflects enormous potential for India to become a key player in international markets.

Source: State/UT Animal Husbandry Departments, 2004
Besides, the per capita milk availability has also shown an impressive growth from 178 gm/day in 1991-92 to 232 gm/day in 2004-05 (Figure 3). This has been despite of remarkable increased in population in India during this period. The increase in milk availability is likely to contribute to surplus milk and milk products for international markets.

Source: State/UT Animal Husbandry Departments, 2004

The dairy industry in India is primarily focussed on serving the domestic market. However, the remarkable growth in production of butter and milk powder is likely to find overseas markets mainly due to excess production. It is predicted that the butter production is likely to increase at 10% in 2005 whereas the skimmed milk powder would increase at 15% which is likely to increase export of these products.

The export of dairy products has significantly grown up from Rs. 12.47 crores in 1993-94 to Rs. 115.19 crore in 2003-04 (Figure 4) in value terms whereas in terms of quantity it has increased from 2106 metric tonnes in 1993-94 to 15883 metric tonnes in 2003-04. It is obvious that there has been remarkable growth in exports of dairy products in India during the last five years. The industry should identify the bottlenecks and target niche segment of international markets.

The skimmed milk with fat content less than 1.5% accounted for 37.5%, melted butter (ghee) (23.84%), milk food for babies (11.62%), other milk cream (7.12%) other milk powder

Source: DGCI&S
(6.11%), milk for babies (3.05%), curdled milk and cream (acidified) (2.94%) and others (7.81%) during 2003-04 as indicated in Figure 5.

Source: DGCI&S

The trends of dairy exports indicate decrease in exports of skimmed milk from Rs. 10780 lakhs in 2001-02 to Rs. 3265 lakhs in 2003-04. Melted butter (ghee) had significant exports of Rs. 2076 lakhs in 2003-04. Indian firms need to focus upon value added products with higher unit value realisation so that geographically distant markets can be tapped with higher profitability. It is encouraging to note that the value added milk products had increasingly gained significance in India’s export basket as given in table 1.
The major markets for exports of dairy products from India include Germany, USA, UAE, Bangladesh and Nepal.

**Impact of World Trade Organisation (WTO) on International Marketing of Dairy Products**

On January 01, 2005, World Trade Organisation (WTO) came into existence as a successor of General Agreement of Trade and Tariff. It is the only international organisation that deals with global rules of trade between the nations. The basic objectives behind strengthening the rule based system of the international trade under WTO are to ensure that the international markets remain open and their access is not disrupted by sudden and arbitrary imposition of import restrictions.

Creating fairer markets in the agricultural sector including dairying has been the major contribution of WTO. Although, the earlier rules of GATT did apply to agriculture trade but it contained loopholes. Some developed countries protected their costly and inefficient production of temperate zone agricultural products (e.g. wheat and other grains, meat and dairy products) by imposing quantitative restrictions and variable levies on imports in addition to the high import tariffs. This level of protection often resulted in increased domestic production which because of high prices, could be disposed off in the international markets only under subsidy. Such subsidised sales depressed international market prices of such agro products including dairy products. It also resulted into taking away of legitimated market share of competitive producers in the agro sector.

As a result, the international trade in agriculture became highly “distorted” especially with the use of export subsidiaries, which would not normally have been allowed for industrial products. Trade is termed as “distorted” if prices are higher or lower than normal, and if quantities produced, bought, and sold are also higher or lower than normal than the levels that usually exist in a competitive market.

The Uruguay Round produced the first multilateral agreement dedicated to agriculture sector. The objective of the agreement on agriculture has to reform trade in agriculture (including dairy sector) and to make policies more market oriented.

**Binding Against Further Increase of Tariffs**

In addition to elimination of all non-tariff measures by tariffication, all countries have bound all the tariffs applicable to agricultural products. In most cases, developing countries have given binding at rates that are higher than their current applied or reduced rates.

**Domestic Support**

National policies that support domestic prices or subsidised production often encourage over production. This squeezes out imports or lead to export subsidies and low price dumping in international markets. Under the agreement of agriculture domestic policies that have a direct effect on production and trade have to be cut back. The domestic support in the agriculture sector is categorised under Green, Amber and Blue boxes as shown in Exhibit 1.

**Exhibit 1: Categories of Domestic Support in Agriculture Sector**

- **Green Box**: All subsidies that have little or at most minimal, trade distorting effects and do not have the “effect of providing price support to producers”, are exempt from reduction commitments. The subsidies under the Green Box include:
  - Government expenditure on agricultural research, pest control, inspection and grading of particular products, marketing and promotion services.
• Financial participation by government in income insurance and income safety-net programmes.
• Payments for natural disaster.
• Structural adjustment assistance provided through:
  i. Producer retirement programmes designed to facilitate the retirement of persons engaged in marketable agricultural production.
  ii. Resource retirement programmes designed to remove land and other resources, including livestock, from agricultural production
  iii. Investment aids designed to assist the financial or physical restructuring of a producer’s operations.
• Payments under environmental programmes.
• Payments under regional assistance programmes.

**Amber Box**

This category of domestic support refers to the Amber colour of traffic lights, which means “slows down”. The agreement establishes a ceiling on the total domestic support that government may provide to domestic producers.

**Blue Box**

Certain categories of direct payment to farmers are also permitted where farmers are required to limit production. This also includes government assistance programmes to encourage agricultural and rural development in developing countries, and other support on a small scale when compared with the total value of the product or products supported (5 percent or less in the case of developed countries and 10 percent or less for developing countries). Source: WTO

The member countries quantified the support provided per year for agriculture sector, termed as “total aggregate measurement of support” (total AMS) in the base years of 1986-88. Developed countries agreed to reduce total AMS by 20 percent over six years starting in 1995 while the developed countries agreed to make 30 percent cut over ten years. Least developed countries were not required to make any cuts in AMS. The AMS is calculated on a product-by-product basis by using the difference between the average external reference price for a product and its applied administered price multiplied by the quantity of production. To arrive at AMS, non-product-specific domestic subsidies are added to the total subsidies calculated on a product-by-product basis.

**Export Subsidies**

The agreement on agriculture prohibits export subsidies on agricultural products unless the subsidies are specified in a member’s lists of commitments. Where they are listed, the agreement requires WTO members to cut both the amount of money they spend on export subsidies and the quantities of exports that receive subsidies. Taking averages for 1986-90 as the base level, developed countries agreed to cut the value of export subsidies by 36 percent over the six years starting in 1995 (24 percent over 10 years for developing countries). Developed countries also agreed to reduce the quantities of subsidised exports by 21 percent over the six years (14 percent over 10 years for developing countries). Least developed countries do not need to make any cuts. During the six year implementation period, developing countries are allowed under certain conditions to use subsidies to reduce the costs of exports marketing and transporting.
Standards and Safety Measures for International Markets

Under article 20 of the General Agreement on Tariffs and Trade (GATT) allows governments to act on trade in order to protect human, animal or plant life or health, provided no discrimination is made and it is not used as disguised protectionism. In addition there are two specific agreements dealing with food safety and animal and plant health and safety with product standards.

The Agreement on Sanitary and Phytosanitary (SPS) Measures sets out the basic rules on food safety and plant health standards. This allows the countries to set their own standards which have to be based on the science and should be applied only to the extent necessary to protect human, animal or plant life or health. These regulations should not arbitrarily or unjustifiably discriminate between countries were identical or similar conditions prevail. Member countries are encouraged to use international standards such as FAO/WHO Codex Alimentarius Commission for food, International Animal Health Organisation for animal health etc. However, the agreement allows countries to set higher standards with consistency. The agreement includes provisions for control, inspection and approval procedures. The member governments must provide advance notice of new or changed sanitary and phytosanitary regulations and establish a national enquiry point to provide information.

The Agreement on Technical Barriers to Trade (TBT) tries to ensure that regulations, standards, testing and certification procedures do no create unnecessary obstacles to trade. This agreement complements with Agreement on Sanitary and Phytosanitary (SPS) measures. Firms engaged in international marketing and manufacturing products for international markets need to know about the latest standards in their prospective markets. All WTO member countries are required to national enquiry points to make this information available.

Major Challenges in Promoting Exports of Dairy Products from India

Dairy exports from India face a number of challenges that may be summarised as follows:

- Prevalence of Livestock Diseases such as Foot and Mouth Disease (FMD)
- Importers’ insistence on labelling dairy products as manufactured from cow milk
- Quality issues related to pesticides and antibiotics
- Small animal holdings making it difficult to introduce mechanised system of milking and milk holding
- Low milk yield vis-à-vis exotic cattle
- Low surplus for exports as domestic consumption is very high

Strategy for Promoting Dairy Exports from India

India needs to address effectively the above challenges affecting export of dairy products. The export promotion strategy would include developing and implementing effective mechanism for control of livestock diseases, creating awareness in the international markets about nutritional aspects of buffalo milk vis-à-vis cow milk, consistent and effective efforts to improve the milk yield.

Moreover, as import tariffs have considerably declined and quota restrictions fast disappearing in international markets, there is a strong fear that high income countries are increasing making use of quality standards as a formidable barrier to dairy products from India and other developing countries. The research institutions and scientists in India need to keep a close vigil on such mandatory quality specifications in international markets so as to overcome the newly emerging international marketing barriers. Thus, the key to successfully overcome the emerging challenges in international markets lies in the hands of bright scientists and technologists of India.
Global Trends in Major Dairy Products Trade

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Centre for International Trade in Agriculture and Agro-based Industries (CITA) New Delhi

Fluid Milk

Production

Cow milk is the most common type of fluid milks produced by various countries of the world which contributes about 84 per cent of the global fluid milk production. The global fluid milk production has shown a steady rise over last ten years period. During 2004 the world milk production was recorded to be 613 Mio tones, an increase of 77 Mio tones since 1995.

India contributes a major share in world milk production with an average production of 90 Mio tones of fluid milk during 2002-04 followed by United States (77 Mio tones). Other major producers include Russian Federation, Pakistan, Germany, France, Brazil, China, New Zealand and The United Kingdom.

Table : Major fluid milk producing countries of the world during last five years (Units in Mio Mt)

<table>
<thead>
<tr>
<th>Country</th>
<th>Production in Mio Mt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
</tr>
<tr>
<td>India</td>
<td>80.8</td>
</tr>
<tr>
<td>USA</td>
<td>76.0</td>
</tr>
<tr>
<td>Russian Fed.</td>
<td>32.3</td>
</tr>
<tr>
<td>Pakistan</td>
<td>25.6</td>
</tr>
<tr>
<td>Germany</td>
<td>28.4</td>
</tr>
<tr>
<td>France</td>
<td>25.7</td>
</tr>
</tbody>
</table>

Source: FAO Database

Buffalo milk production is limited to around 18-20 countries around the world with India contributing a maximum of 66 per cent of the total buffalo milk production (during 2002-04). Other major buffalo milk producers include Pakistan, China, Egypt and Nepal.

Sheep and Goat milk contribute about 1-2 per cent of the total fluid milk production but unlike buffalo milk more than 70 countries produce sheep and goat milk. Major sheep milk producing countries include China, Italy, Turkey and Greece whereas major goat milk producing countries include India, Bangladesh, Sudan and Pakistan. The global goat milk production over last ten years period show a stable increase in production from 11.2 Mio Mt to 11.8 Mio Mt, whereas the sheep milk production shows a fluctuating trend since 1995 to 2004.

Presently the European Union is the largest producers of cow milk in the world with 142 Mio Mt of production during 2004 and this is expected to remain more or less stable for the next ten years period as the Food and Agricultural Policy Research Institute (FAPRI) estimates. Cow milk production of India is expected to rise to 44.8 Mio tons by the year 2014 from the current level of 38.2 Mio tons in 2004. Similarly cow milk production of USA is estimated to rise to 85.6 Mio tons by the year 2014 which is a considerable rise from the current level of 77.3 Mio tons.
Consumption

Fluid milk consumption has globally increased since last decade however, the Asian countries especially India and China show a sharp rise in milk consumption as compared to other milk consuming countries. Contrary to this, the European Union which is far the largest consumer of fluid milk exhibits a marginal decline in consumption of this product since 1994. Other major consumers of fluid milk such as US, and Russia also show a decline in milk consumption.

Fluid milk consumption trend over last ten years

The consumption trend for the next ten years (i.e. 2004-2014) is believed to remain more or less in the same fashion with India, China, and Brazil continuing to increase consumption levels whereas EU, USA, and Russian Federation maintaining a more or less stable trend of fluid milk consumption.

Export

Export market for fluid milk is worth US$ 2.9 billion however nearly one per cent of the fluid milk produced globally is exported. Export of fresh milk mainly occurs from the European countries and this market is dominated by Germany, France, and Belgium contributing on an average 31%, 14% and 13% respectively of the world exports in terms of quantity. Other countries like Netherlands, Austria, UK and Spain have less than 10% of the export share in the world market.

Although India is a major producer of fluid milk, most of the domestic production is consumed locally due to which export is very negligible as compared to the major European players.
Top Ten Exporters of Fresh Milk during 2001-03

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Country</th>
<th>Exports Qty (Mt)</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Germany</td>
<td>1,905,654</td>
<td>1,892,897</td>
<td>2,117,560</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>France</td>
<td>993,921</td>
<td>829,293</td>
<td>856,077</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Belgium</td>
<td>863,150</td>
<td>846,890</td>
<td>772,409</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Netherlands</td>
<td>253,901</td>
<td>285,385</td>
<td>608,793</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Austria</td>
<td>672,936</td>
<td>625,898</td>
<td>542,832</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>United Kingdom</td>
<td>148,943</td>
<td>159,364</td>
<td>312,021</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Spain</td>
<td>199,345</td>
<td>199,468</td>
<td>208,489</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Portugal</td>
<td>149,813</td>
<td>172,994</td>
<td>154,447</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Luxembourg</td>
<td>101,103</td>
<td>113,631</td>
<td>118,952</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Ireland</td>
<td>91,110</td>
<td>88,203</td>
<td>98,332</td>
<td></td>
</tr>
</tbody>
</table>

Source: FAO Database

Import

The import value of the fluid milk is greater than the value gained from exports. Fresh milk imports of average 7 Mio Tons and worth US$ 3.2 billion was imported during 2001-03. Countries that are major exporters are also major importers of fresh milk with Italy, Germany, Belgium and France importing a major share of 28%, 14%, 13%, and 11% respectively in the global imports of fresh milk.

Top Ten Importers of Fresh Milk during 2001-03

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Country</th>
<th>Imports Qty (Mt)</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Italy</td>
<td>2,021,853</td>
<td>1,902,973</td>
<td>1,997,649</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Germany</td>
<td>680,966</td>
<td>933,855</td>
<td>1,404,341</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Belgium</td>
<td>901,342</td>
<td>999,852</td>
<td>1,001,262</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>France</td>
<td>953,397</td>
<td>795,904</td>
<td>740,960</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Netherlands</td>
<td>476,800</td>
<td>458,622</td>
<td>494,712</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Spain</td>
<td>282,372</td>
<td>400,743</td>
<td>375,096</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Ireland</td>
<td>211,805</td>
<td>220,665</td>
<td>247,652</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>United Kingdom</td>
<td>109,823</td>
<td>61,905</td>
<td>172,822</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Portugal</td>
<td>113,251</td>
<td>93,238</td>
<td>81,373</td>
<td></td>
</tr>
</tbody>
</table>

Source: FAO Database

Cheese

Fresh or ripened cheeses are made from the coagulation of casein and the separation of whey from milk, cream, buttermilk or a combination of these products. Normally, casein coagulates under the combined pressure and acidity produced by the lactic starter. After coagulation, cheese undergoes a number of steps aimed at separating the whey from the
curd, followed by an aging step of variable duration. The ripening of cheese (aging) allows characteristic flavor to develop through microbial and enzyme activity. Cheese is produced from cow, goat, or sheep milk.

**Production**

U.S. is the biggest cheese producer, with close to 25% of total world production. Germany and France rank second and third, respectively. Cheese production worldwide has significantly increased since last few years. Total cheese production in the year 2000 was 18.9 Mio MT which has increased by 1.6 Mio MT to 20.5 Mio MT in the year 2004.

Cheese production of European Union and EU-15 was 6.1 and 5.6 Mio MT respectively during 2004. European Union along with EU-15 contributes nearly 60% of the global cheese production. United States with a production of 4 Mio MT during 2004 was the second largest cheese producer and contributed more than 18% to the global cheese production.

Whole milk cow cheese contributes a major share in production of all kinds of cheeses worldwide and the increase of 1.65 Mio MT in total cheese production is mainly due to whole milk cow cheese, where the production has risen by almost 1.5 Mio MT during the years 2000 to 2004. Other kinds of cheeses namely the cheese produced from sheep milk, goat milk and buffalo milk also show a marginal rise in production.

![Global Cheese Production of Various types during 2004](Source: FAO Database)

The large scale production of whole milk cow cheese that has increased significantly in recent years suggests a higher market demand for this commodity than any other kinds of cheeses.

United States is the largest producer of whole milk cheese with a production of 4 Mio MT in the year 2004. Countries like France, Germany and Italy produce on an average 1-1.6 Mio MT (2000-04). All the other countries including Netherlands, Poland and the UK produce less than 1 Mio MT of whole milk cow cheese.

**Consumption**

Cheese consumption scenario is almost similar to that of the production situation with EU being the largest consumer of cheese followed by the USA. Besides these major players
the cheese consumption in Asian markets shows a significant rise in recent years. Cheese consumption in Russian Federation was 354 Mio MT during 1994 which has risen by 154 Mio to 508 Mio MT in 2004 whereas a rise of 77 Mio MT and 46 Mio MT respectively has been observed in Japan and China respectively that consumed nearly 250 Mio MT of cheese annually during 1994. There are possibilities that cheese consumption in future in most of the Asian markets is likely to further increase to a considerable extent with the modernization and increase in the household incomes of the people who are increasing looking for inclusion of value added products in their daily diets.

Export

The share of value earned from the export of other dairy products like whole milk, fresh milk, dry milk and butter seem to either decline or remain stable over last 10 years. However, cheese is becoming an expensive commodity among all the dairy products. Value earned from the export of cheese is higher than that of other dairy product exported in the world market. All kinds of cheeses worth US$12 billion were exported during 2003 which is almost US$ 2.5 billion higher than the previous year’s value and highest value over the last 10 years period.

Value Earned from Export of Selected Dairy Products in the World Market

The world’s major cheese exporters are the European Union (25), New Zealand and Australia, whose combined exports totaled 76% of world exports in 2004.

On an average 3.2 Mio MT of whole milk cow cheese worth US$ 10 billion was exported in the world market (2000-04). Major exporters include Germany, France, Netherlands, New Zealand and Denmark.

Net cheese exports from New Zealand has almost doubled over the last ten years period whereas that of the European Union has declined considerably from 0.4 Mio MT in 1995 to 0.35 Mio MT in the year 2004. Net exports from other major players like USA, Russia, and Japan show a negative growth during 1994-2004.

The 2005 forecast for total cheese exports in selected countries is revised down as a result of a cut in New Zealand exports following a disappointing production season and a drop in EU exports. A reduced export from the EU is mainly due to the limited availability of exportable supplies as a result of strong growth in domestic consumption. In terms of major cheese exporters it appears that cheese exports during the 2002-2005 would remain virtually stagnant suggesting that the recent global price increases are attributable primarily to import
demand growth by major cheese importing countries. In fact, the cheese imports in selected countries have jumped by nearly 171,000 tons in the period 2000 through 2005.

Net Cheese Exports of Selected Countries in the World Market

<table>
<thead>
<tr>
<th>Country</th>
<th>Net Cheese Exports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country 1</td>
<td>1,000 Mt</td>
</tr>
<tr>
<td>Country 2</td>
<td>2,000 Mt</td>
</tr>
<tr>
<td>Country 3</td>
<td>0 Mt</td>
</tr>
<tr>
<td>Country 4</td>
<td>5,000 Mt</td>
</tr>
</tbody>
</table>

Import

Cheese imports by Japan have considerably increased in the recent years. The preliminary estimates of 2004 suggested an export of 219,000 Mt of cheese import which was almost 10,000 Mt higher than the amount of cheese imported by the largest importer the United States (209,000 Mt). Similar is the situation in Russia where cheese imports have almost tripled over the last 3 years, i.e. increased from 60,000 Mt in the year 2000 to 190,000 Mt in 2004. Mexico and other Asian countries also exhibit a considerable rise in cheese imports.

Cheese imports of the European Union has significantly reduced its imports owing to enhanced domestic production and a sharp reduction in the exportable supplies of major dairy commodities as a result of growing cheese consumption.

Cheese Import Share of Major Countries during 2003-04

<table>
<thead>
<tr>
<th>Country</th>
<th>Cheese Import Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country 1</td>
<td>10%</td>
</tr>
<tr>
<td>Country 2</td>
<td>20%</td>
</tr>
<tr>
<td>Country 3</td>
<td>5%</td>
</tr>
<tr>
<td>Country 4</td>
<td>15%</td>
</tr>
</tbody>
</table>

Source: FAO Database
Butter

This category includes butter and butter portions. Butter oils include anhydrous milk fat (AMF) and ghee. AMF is butter with the water content removed, and is used primarily for exports and domestic food processing applications such as bakery and confectionery.

Production

The global butter production during 2004 was 9.4 Mio Mt up by 1.1 Mio Mt compared to the year 2000. Butter production of India and the European Union was highest and together contributed almost 70% of the world production share in 2004. Russia which had been one of the major producers of butter during 1990s has reduced the production of this commodity to a significant extent. New Zealand on the other hand contributes 4.3% of the world production share of butter and is emerging as one of the major butter producers in world market after USA which contributes on an average 5.9% production share.

### Top Producers of Butter from Cow milk

<table>
<thead>
<tr>
<th>Countries</th>
<th>% Production Share (average of 2000-04)</th>
</tr>
</thead>
<tbody>
<tr>
<td>US</td>
<td>12.13</td>
</tr>
<tr>
<td>New Zealand</td>
<td>8.81</td>
</tr>
<tr>
<td>Germany</td>
<td>9.21</td>
</tr>
<tr>
<td>France</td>
<td>9.31</td>
</tr>
<tr>
<td>Russian Federation</td>
<td>5.80</td>
</tr>
<tr>
<td>Poland</td>
<td>3.74</td>
</tr>
<tr>
<td>Ukraine</td>
<td>3.14</td>
</tr>
<tr>
<td>UK</td>
<td>2.97</td>
</tr>
<tr>
<td>Ireland</td>
<td>3.05</td>
</tr>
<tr>
<td>Iran</td>
<td>2.81</td>
</tr>
</tbody>
</table>

Consumption

India is the largest consumer of butter with a consumption of 2.6 Mio Mt of butter in 2004 and the consumption trend shows a continuous rise over last 5 years. Butter is a fat based dairy product and regarded as a source of obesity by most of the developed countries. European Union is the second largest consumer however the consumption trend exhibits a slight decline in recent years. Other major consumers of butter include USA, Russia, Ukraine, and Mexico that consume less than 0.7 Mio Mt of butter annually.

Exports

In terms of butter trade, revisions have been principally on the export side. The New Zealand 2005 export forecast has been adjusted down by 16 percent due to lower milk production. The longer term trend has been for a decline in butter exports as the focus has shifted to the higher returns gained from WMP and cheese exports. EU butter exports for 2004 and the 2005 forecast year have been adjusted upwards but the year-to-year change is negligible. EU butter production has been declining over the past several years and despite a drop in consumption, available supplies for the export market will likely remain limited. In fact, EU ending stocks for 2005 are forecast to drop by 22 percent.
Top Exporters of Butter from Cow milk

<table>
<thead>
<tr>
<th>Countries</th>
<th>Export Share in percent (average of years 2000-03)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Zealand</td>
<td>26.14</td>
</tr>
<tr>
<td>Netherlands</td>
<td>12.58</td>
</tr>
<tr>
<td>Belgium</td>
<td>8.77</td>
</tr>
<tr>
<td>Ireland</td>
<td>8.50</td>
</tr>
<tr>
<td>Germany</td>
<td>4.31</td>
</tr>
<tr>
<td>Australia</td>
<td>7.52</td>
</tr>
<tr>
<td>France</td>
<td>5.38</td>
</tr>
<tr>
<td>Denmark</td>
<td>3.43</td>
</tr>
<tr>
<td>UK</td>
<td>3.16</td>
</tr>
<tr>
<td>Finland</td>
<td>2.71</td>
</tr>
</tbody>
</table>

Imports

Butter imports of Russia have increased significantly over the last 5 years. Nearly 60,000 Mt of butter was imported in the year 2000 whereas the imports in 2004 are up by 110,000 Mt. Russia is the largest butter importer followed by the European Union (25) which exhibits a stable import trend due to a shift on consumption of cheese. Other major importers of butter such as Mexico, Egypt, Canada and USA also show more or less stable imports of this product since the year 2000. India despite being a major consumer of butter

Top Importers of Butter during 2000-04

<table>
<thead>
<tr>
<th>Country</th>
<th>Quantity in 000' Mt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
</tr>
<tr>
<td>Russia</td>
<td>60</td>
</tr>
<tr>
<td>European Union - 25</td>
<td>88</td>
</tr>
<tr>
<td>Mexico</td>
<td>34</td>
</tr>
<tr>
<td>Egypt</td>
<td>49</td>
</tr>
<tr>
<td>Canada</td>
<td>15</td>
</tr>
<tr>
<td>United States</td>
<td>15</td>
</tr>
<tr>
<td>Algeria</td>
<td>0</td>
</tr>
<tr>
<td>Taiwan</td>
<td>0</td>
</tr>
<tr>
<td>India</td>
<td>10</td>
</tr>
<tr>
<td>Australia</td>
<td>10</td>
</tr>
</tbody>
</table>

Milk powders

Milk powders include skim milk powder (SMP), whole milk powder (WMP), buttermilk powder (BMP) and milk protein concentrates. Milk powder can be recombined into liquid milk products, particularly in tropical climates where fresh milk supplies are not available. It is also used in bakery, confectionery and milk chocolates, processed meats, ready-to-cook meals, baby foods, ice-cream, yogurt, health foods, reduced-fat milks and animal fodder.
Given higher returns from cheese production and a declining supply of fluid milk, some milk is diverted from NFD into cheese production.

**Production**

**Non-Fat Dry Milk**

United States is the largest producers of non-fat dry milk with a production of 0.63 Mio Mts during 2004. New Zealand’s production (0.3 Mio Mts) was about half the quantity compared to that of the USA during 2004; however the NFD production trend shows a continuous growth over the last few years. At the same time Australia used to produce larger quantities of NFD as compared to New Zealand but has reduced the production of this commodity since 2002. India is the largest producer of NFD among Asian countries and is also one of the leading producers in the world market. As per the forecast of FAPRI the quantity of NFD produced by India during 2005 (0.27 Mio Mts) is expected to be higher than that produced by New Zealand owing to an anticipated decline in the production of the latter.

**Consumption**

The largest producer of Non-fat dry milk, the United States is also a largest consumer of this product. The consumption of NFD by USA during 2004 was 0.62 Mio Mt which has almost doubled compared to that of the year 2000 (0.34 Mio Mts). Mexico is the second largest consumer of NFD with a consumption of 0.3 Mio Mts during 2004; however, the consumption trend is more or less stable and has shown a negligible rise over last 3-4 years period. India on the other hand has increased its consumption of NFD and is expected to surpass the consumption demand of Japan which shows a declining trend for this commodity. Part of the reason seems to be that Japan is shifting towards more valuable products like cheese and flavored milk beverages whereas India’s growing demand for a number of milk items seems to be satisfied by the NFD which can be converted into a number of varied products by reconstitution.

**Exports**

Non-Fat Dry Milk Imports exhibit major changes on the export front as far as world market is concerned. New Zealand is one of the major exporters of NFD to the world market with 0.31 Mio Mts of export during 2004. New Zealand exports of NFD had shown a continuous increase during 2000-04, but are expected to reduce its exports in 2005. Contrary to this trend the neighboring country, Australia has continuous reduced its exports of NFD to the world market. Australia used to export larger quantities of this commodity as compared to New Zealand during 2000 (0.25 Mio Mts), however the exports during 2004 suggest a decline of almost 0.1 Mio Mts. United States on the other hand has been able to increase her exports by almost 0.1 Mio Mts over the last 2 years period.
Imports

Major importers of NFD are the countries that have limited milk supply or production capabilities because of poor income, transport infrastructure, roads and lack of refrigeration facilities. Owing to high prices and limited supply, milk is perceived as a luxury product in such countries. Powdered milk are mainly imported to reconstitute it into various types of milk products to satisfy the routine demand for milk such as feeding infants, tea or other beverages.

Mexico is the largest importer of NFD in the world market with imports rising from 0.29 Mio Mts of during 2000 to 0.7 Mio Mts of during 2004. Indonesia and Philippines are other two major importers of this product which exhibit a constant rise in their imports of NFD over the last 4 years. Interestingly China where milk is perceived as an infant food had been very poor importers of NFD in the past however, in recent years China’s NFD imports have showed a dramatic rise from 22,000 Mt during 2000 to 88,000 Mt in 2005. The growth trend for this commodity in China is expected to continue over next few years, which is going to increase the import demand for this commodity in the International markets.

Source: FAPRI Database
Forecast

Over the next decade, the world NFD production is expected to rise 16.7%, with the greatest gains occurring in Australia, New Zealand, Russia, and China. With the exception of the EU, WMP production would grow in most countries, increasing a total of 24.3%. NFD and WMP prices rise annually by 2%.

NFD production in the EU NMS would decrease by about 6% over the baseline. Some NFD is exported to the EU-15 at the expense of exports outside the EU.

Given the surplus supply of milk, milk powder production in Australia and New Zealand continues to grow.

As a by-product of butter, India’s NFD production would grow 56.9%, creating excess supplies that allow NFD exports to rise 17.2% annually.

Strong devaluation and firm world prices drive the recovery of the Argentine dairy sector. Argentine WMP and NFD productions increase 5.6% and 4.8% annually, respectively, over the baseline.

Australia, New Zealand, the EU, and the U.S. captured about 87% of the NFD export market in 2004, and they keep their market shares over the baseline. NFD exports from Australia and New Zealand grow an average of 4.3% and 1.7% annually, respectively, while NFD exports from the EU decline in the first half of the baseline.

Mexican NFD imports are strong, averaging 179 tmt over the projection period. Southeast Asia (Indonesia, Malaysia, and the Philippines) increases its share of total NFD imports from 23% in 2004 to 34% in 2014. China and Japan account for about 9% of the NFD import market by the end of the baseline. Together, these five countries generate virtually all of the growth in NFD trade.

Higher milk production, driven by some favorable investment credit programs and government policies and a favorable exchange rate, change Brazil from a WMP importer to a net exporter.

Southeast Asian WMP imports rise 4.4% annually throughout the projection period. Chinese WMP imports decline over the long term, as domestic WMP production expands and as consumers substitute fluid milk for reconstituted milk powder.
Futuristic Trends in Use of New Ingredients in Dairy Products

DR. RAVINDRA KUMAR
Technical Director, Danisco (India) Pvt. Ltd., Gurgaon

In recent years ingredients market in India is witnessing an explosive growth, which was never seen earlier. As consumers are becoming more and more health conscious, the demand for more indulgent foods that have reduced fat, no sugar added and are reduced in calories is likely to increase. With the advancement in functional ingredients e.g., emulsifier/stabilisers blends, Pro-biotic cultures, sugar and fat replaces, masking flavours, etc., it is now possible to manufacture dairy products, which are sugar-free, low calorie, low fat and have specific health benefit without compromising the taste & texture. Thanks to the innovation in technology, distribution, communication coupled with positive demographic changes leading to the new product development and launches in the market, which are seen by many consumers as a way to provide general health and well-being. These dairy products are often referred as functional foods as they provide specific health benefits using our knowledge of nutrition & health relationship. Further, the positive legislative changes in the PFA Rules will pave the way for new launches and keep the functional food market on an upward trajectory in future. The health & wellness concept has added a new dimension to this scenario due to the following reasons:

**Alarming Increase in Obesity**

According to FAO/WHO release 1.2 billion people are overweight and app 250 Million people are obese. World over overweight is a bigger problem than under-nourishment.

**Diabetics**

Word wide 177 million or 5.2 % of adult population are affected. The majority of this population is in Asia. Type 2 or non-insulin dependent diabetes mellitus account for 95 % of all cases, which can be, managed through diet modifications especially the type of carbohydrates.

**Osteoporosis**

As per the WHO study the lifetime risk for Osteoporosis for women is between 30 and 40%. Calcium, Vitamin D and exercise are essential for prevention of Osteoporosis. Health benefits and claims such as “calcium leads to bone health” are associated with dairy products and are easily recognized by the consumers.

**Healthy Foods Sales is Likely to Increase**

There is an increasing consumer awareness of relationship between diet and health. Further, the customers are willing to pay extra for foods that can give some health benefits.

**Consumer Demand for Low Calories Foods**

Low calorie, reduced calorie foods and diabetic foods are becoming increasingly popular in all segments of food industry. This is seen by the launch of many low calorie ice cream and milk variants. The above factors are responsible for creation of new market segment with enormous opportunities, which can be encased by being creative and innovative. Health concerns have also created a boom in low fat, low calorie foods. This has led to strong demand for flavourings, which effectively mask the taste of sweeteners and artificially recreate the mouth feel of fat. Greater product diversity and more consumer choice are expected to drive the growth in this health & functional food segment.
Sugar Replace

In order to produce dairy products, which are significantly low in calories, it is necessary to reduce or remove the sugar. Bulking agents are needed to replace the loss of dry solids from sugar and retain an acceptable texture. To compensate for the lack of sweetness it is often necessary to apply an intensive sweetener. A number of bulking agents for use in ice-cream/frozen desserts are available e.g., Litesse® polydextrose (1 Kcal/g), Lactitol (2 Kcal/g) and Maltodextrin (4 Kcal/g) are available in the market. The application of sugars with a high level of sweetness (e.g., fructose, which is approx. twice as sweet as normal sucrose) makes it possible to reduce the total sugar content.

For tooth friendly application, xylitol is a sweetener of choice. It has the same sweetness intensity as sucrose, providing a “clean” sweetness with no discernable aftertaste. Xylitol has a positive influence of oral health and it inhibits the growth of Streptococcus Mutans, which is associated with tooth decay. A daily intake of 3-5 gram Xylitol will positively reduce tooth decay, plaque growth and plaque acidogenicity. The frozen desserts, which have xylitol in their recipe, have the following advantages:

- Helps fight bad breath
- Tooth friendly. Inhibits plaque formation
- Reduces tooth decay
- Encourages demineralisation of the teeth
- Good for diabetes

Before developing recipes for low calorie dairy products it is important to understand the functionality of the bulking agents. Foods with Low Glycemic Index (GI) have been scientifically validated as a tool in the management of diabetes and weight reduction. GI factor is a ranking of foods from 0 - 100 that tells us whether a food will raise blood sugar levels just a little, moderately or dramatically. Based on GI Factor foods are classified as:

- Low GI foods <55
- Intermediate GI foods 55 - 70
- High GI foods > 70

Low GI foods are particularly important in maintaining blood sugar levels and managing weight. The FAO/WHO study recommends the use of low GI diets in order to prevent diseases such as Coronary heart disease, Diabetes and obesity. Therefore, the low GI diets are claimed to be healthier and more satiating.

Fat Replacer

Several products with extender and/or fat replacer properties are now commercially available. These fat replacers create a creamy sensation and improve the melt down properties in frozen desserts. The addition of fat replacers compensates for some of the functional properties lost when fat content is reduced. Litesse® polydextrose, Lactitol, Maltodextrin, inulin are often used as fat replacers.

Flavourings

Low calorie dairy products have a reduced fat and/or sugar content. Due to low fat content following problems may be encountered:

- More pronounced taste of individual ingredients
- No masking effect from the fat e.g., oxidised/bitter taste from the dry milk
- Cardboard notes from the gums
- Change is sugar/salt balance
- Pronounced change in Body, texture and mount feel.

To prevent and optimise these problems, it is important to balance the flavouring and avoid volatile top notes. The flavouring dosages can then be reduced by up to 50 %. In
addition, body & mouth feel can be improved by adding flavourings such as milk, cream & butter. Functional flavourings especially developed for low fat and low sugar dairy products are commercially available.

**Pre- and Probiotic**

This is the most promising category, which include products like Dahi, Yoghurt, Lassi, Buttermilk, etc, which is easily recognisable by the Indian consumer. In addition, Ice cream and frozen desserts can be developed containing both probiotic bacteria and pre-biotic carbohydrates (e.g., Lactitol, Polydextrose, etc.). In contrast to probiotic, which are live microbial additions, a pre-biotic is a non-viable component of diet that reaches the colon in an intact form and is selectively fermented by colon bacteria. The studies have indicated that the viability of probiotic bacteria in ice cream changed little over a one-year period.

**Addition of Different Bio-Actives**

A number of whey, casein and dairy protein derived peptides and hydrolysates which act as a bio active peptides are already commercially available. These bioactive peptides can be used to position the products as anti-hypertensive, regulation of fat metabolism, etc. Ice cream and frozen desserts can also be used as vehicles to deliver bioactive dairy peptides.

**Vitamin and Calcium Fortification**

Many Dairy Products can be most readily adapted to nutrient fortification and inclusion of nutraceuticals. Vitamin & calcium fortification is often carried out in infant foods & dairy products targeting women. Omega-3 and omega-6 fatty acids can also be incorporated in the fat phase of the dairy products to provide functional benefits. Therefore, many dairy products can be used successfully to deliver unique nutritional benefits to consumers beyond the basic nutrition of current products.

**Fibre-Enrichment**

Inadequate intake of dietary fibre in the human diet has been implicated in many diseases e.g., constipation, obesity, diabetes, gallstones, lipid metabolism, appendicitis, etc. Polydextrose is a good choice as an economical fiber source for use in ice cream and frozen desserts. Polydextrose is not digested in the upper gastrointestinal (GI) tract and is partially fermented in the lower GI tract, making it a beneficial ingredient for digestive health. The physiological benefits of polydextrose include increased fecal bulk, reduced transit time, lower fecal pH and reduced concentration of putrefactive substances in the colon. Polydextrose’s prebiotic effects help promote growth of beneficial intestinal bacteria, while fermentation in the large intestine yields short-chain fatty acids, including butyrate. Improved GI function has been demonstrated with a daily intake of 4-12g of polydextrose without adverse effects. In addition to the health benefits, polydextrose has multiple functional benefits in ice cream & frozen desserts. The freezing point depression factor is 0.6 vs. sucrose at 1.0; therefore, it can protect the structure of ice cream as it inhibits sugar recrystallization and starch retrogradation. It also improves storage stability by narrowing the difference between the storage temperature and the composite glass transition temperature of maximally frozen concentrated solutions for frozen desserts (Tg’). The relative sweetness of polydextrose is practically zero so the sweetness of the finished product can be adjusted by using high-intensity sweeteners. Fortification can be as simple as adding protein, vitamins, minerals or complex carbohydrate. It can be a bit more complex through the addition of a variety of biologically active “nutraceutical” compounds.
Regulatory Issues

In light of the health platform for dairy products it is pertinent to examine the current regulatory scenario in India. Food labelling is the primary means of communication between the producer and seller of food on one hand, and the purchaser and consumer on the other. Brand loyalties are also attributed to the fact that label provides manufacturer's guarantee on food safety & quality. Consumers have started understanding that food contain nutrients which if deficient can cause deficiency diseases or medical affliction. The food labels help the consumer to choose right food. Indian consumer is now exposed to variety of food products not only from India but from across the border also due to globalisation of food trade. In order to communicate the health benefits of two types of claims can be used. Nutritional claim and Health claims. Nutritional claim refer to the composition of the food and do not inform the consumer directly about the effect the food may have on the body. Health claims, on the other hand, inform the consumers about the beneficial effect the food has on the body. The health claims connected to functional foods are either type A health claims that they enhance body functions or type B claims that they reduce the risk of disease. Consumers in India often compare the label of imported food which gives enormous amount of information varying from Nutritional labelling to Health and Functional claims with that of similar food products which are available on the shelves of supermarkets and is disappointed by not finding information which can be used while selecting the food. Therefore, there is an urgent need to form regulatory guidelines which can used for making Nutritional and Health claims in India. In the framework of Codex, matters relating to nutrition are of competence of the Committee on Nutrition and Foods for Special Dietary uses (CCNFSDU) while Codex Committee on Food labelling has elaborated general standard of labelling of pre-packaged food and guidelines on claims and nutritional labelling. Harmonisation of food labelling provisions with those of Codex is the need of the hour. Many developed and developing countries have already harmonised their food labelling legislations with those of Codex. This has benefited the consumer and producer alike in these countries by way of new and innovative products being available in the market. Further it will also ensure that the Claims made on the labels are based on sound scientific consensus and are not misleading to the consumer.

The multiplicity of laws and regulations in food sector need to be avoided. Therefore concerted efforts are needed on part of each agency involved in aligning Indian Food Standards with international standards. It is imperative that a coordinated and unified national approach should be established on the part of each agency connected with the programme of food quality and safety so that each becomes complementary to the other in the over all endeavour of ensuring food quality and safety. What is needed is a “seamless interface” between the regulations falling under the jurisdiction of each agency. This will result in organized and complementary food quality and safety requirements that encourage consistent application throughout the food producing industries and traders. It will also improve India's image as a country that is concerned about improving food quality and safety.

Conclusion

Consumers are becoming more and more health conscious. As a result of this, the demand for more indulgent foods that have reduced fat, no sugar added and are reduced in calories is likely to increase. Therefore, functional dairy products should address the widespread health issues to have significant consumer appeal. In order to be successful, the functional dairy products should give tangible benefits to the consumers which are supported by documented sound scientific investigations and associated claims must be sensible and credible. This need to be supported by bringing guidelines in nutrition and health claims and also permitting compositional modifications as envisaged in Gazette notification No. G.S.R.356 (E) dated 7th June 2005.
Traditional Milk Based Products of Southern India - Scope for Value Addition

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The southern part of India comprising the states of Karnataka, Tamil Nadu, Andhara Pradesh and Kerala accounts for nearly 23% of the milk produced in the country. In recent times all the southern states have made progress in dairy development under cooperative and private sectors. The states of Karnataka and Tamil Nadu are vying for top slots in dairy development and also in diversification of milk for the production of value added products.

Traditionally milk and milk products are consumed in different form in different parts of Southern India. In this category milk based payasams and curd rice forms one of the largest segment. Apart from these some of the products like Kalan (Vegetable cooked in Dahi), Moore Kolumbu (products like kadhi) are also produced in different states. Some salient points about these products and the scope and opportunities for the commercial scale production and discussed in the present paper.

Payasam

Payasam is a traditional sweet delicacy prepared on auspicious occasions like marriages, festivals and social functions. It is also served as a dessert in southern states.

Visit to different places in the states of Andhra Pradesh, Karnataka, Kerala and Tamil Nadu, interaction with locals and collection and analyses of samples revealed that Payasam has many varieties with specialities and distinct characteristics attributed to the area specific traditional method of preparation.

Popularity of different varieties of Payasams varied from state to state. The popular varieties of Payasams found in the southern states are shown in Table-1. Vermicelli Payasam is very popular in all southern states. While Shirkurma and Gil-E-Firdaus are the specialities of Hyderabad city of Andhra Pradesh, Khus-khus is a speciality in Karnataka, Palada Payasam in Kerala and Thirattupal in Tamil Nadu.

Table1. Popular varieties of Payasams in Southern States

<table>
<thead>
<tr>
<th>State</th>
<th>Most popular</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andhra Pradesh</td>
<td>Varmicelli, Sago</td>
<td>Shir-Kurma, Gil-E-Firdaus, Firni</td>
</tr>
<tr>
<td>Karnataka</td>
<td>Vermicelli (Shyavige)</td>
<td>Poppy seeds (Khus Khus)</td>
</tr>
<tr>
<td></td>
<td>Bengal gram dhal (Kadle bele)</td>
<td>Moong dhal (Hesaru bele)</td>
</tr>
<tr>
<td>Kerala</td>
<td>Pal, Palada</td>
<td>Vermicelli (Shyavige)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bengal gram (Parippu)</td>
</tr>
<tr>
<td>Tamilnadu</td>
<td>Pal, Vermicelli</td>
<td>Thirattu, Pal</td>
</tr>
</tbody>
</table>

Classification of Payasam

Based on the characteristic ingredients, the Payasam were classified as pulse, cereal, cereal product, tuber crop product, fruit and seed based. The nature of the characteristics ingredients and the specific names of the Payasam having various suspended solids are given in Table-2.
Table 2. Classification of payasams

<table>
<thead>
<tr>
<th>Type</th>
<th>Characteristic ingredient</th>
<th>Specific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pulse-based</td>
<td>Bengal gram dhal, Green gram dhal</td>
<td>Kadale bele, Hesaru bele</td>
</tr>
<tr>
<td>2. Cereal-based</td>
<td>Rice, Wheat</td>
<td>Halu Kheeru, Pal, Gil-E-Firdaus, Godhi</td>
</tr>
<tr>
<td>4. Tuber product-based</td>
<td>Sago</td>
<td>Sabbakki, Kaddu ki Kheer</td>
</tr>
<tr>
<td>5. Fruit-based</td>
<td>Mango, Jack fruit</td>
<td>Mavina, Halasina</td>
</tr>
<tr>
<td>6. Seed-based</td>
<td>Poopy</td>
<td>Khus Khus</td>
</tr>
</tbody>
</table>

Curd rice

Curd rice forms an important item of everyday diet of an Indian, particularly that of a South Indian. It is also the food that is widely wended in railway stations, bus stands and in market places. But the quality of the product is not up to the expected level. With this background the project was undertaken to standardize the technology for production of curd rice having commercially viable shelf life and to integrate the process with the existing milk product processing line.

Market Survey

The curd rice samples were collected from restaurants from different localities in the city of Bangalore and analyzed for sensory attributes and also for their physical constituents. In addition to the rice and curd, the cord rice contained coriander leaves, curry leaves, and seasoning materials were the common ingredients found in all the market samples. Some samples had cucumber pieces, pomegranate seeds and grape as the constituents in addition to above mentioned materials, to enhance the acceptability of the product. The shelf life of all the market samples was less than 24 hours at ambient temperature (about 30°C).

Selection of Rice

The raw rice varieties available in the grocery shops of Bangalore were screened for their suitability for curd rice production. The Hansa, Sona Massoori, IR varieties and other varieties were procured from the market and cooked by using pressure cooker. Hamsa and IR varieties produced the cooked rice with long and bigger body with gluey consistency, whereas the Sona Massoori variety produced small bodied rice with no glue, which was desirable for production of good quality curd rice. Hence Sona Massoori variety raw rice was selected for further studies.

Preparation of Curd Rice

Initially, the curd rice was prepared in the laboratory following the traditional method. The curd rice was prepared by using Lactococcus lactis ssp. lactis, LF 40 and standard yoghurt culture. The cooked rice was mixed with curd prepared by using the selected cultures. Salt was added @ 1% of curd and rice mixture. Thus prepared curd rice samples were packed in polyethylene pouches and stored at 30°C to study the shelf life. It was found that irrespective of the lactic culture used, all the curd rice samples developed more than 1.2% LA at the end of 2 days of storage and the samples were disliked for its high acidity.
Attempts were made to modify the procedure for curd rice preparation. In this process, toned milk obtained from the experimental dairy of NDRI, Bangalore was boiled for 2 – 3 minutes, cooled to room temperature (about 30°C) and inoculated with Lc. lactis ssp. lactis, LF 40 and yoghurt culture individually. The culture inoculated milk was mixed with the cooked rice and 1% common salt was added to the milk and rice mixture. The mixture was then packed in polyethylene pouches of about 200gm each and incubated at 37°C. Thus in this modified procedure, the fermentation of milk was carried out in presence of cooked rice, unlike in the traditional procedure wherein, the fermentation of milk is carried out before addition to cooked rice. After incubation period of about 14 – 16 hours, the curd rice was obtained. The samples of curd rice were then stored at 37°C and 5°C, to study the shelf life of the product.

At the end of incubation period, the acidity in curd rice samples were in the range of 0.48 – 0.54% lactic acid. The lactic counts varied between 62 X 10^4 and 79 X 10^4/g. the acidity and lactic counts in all the curd samples stored at 37°C showed increasing trend during storage. At the end of 3 days of storage, the acidity in curd rice prepared by using yoghurt culture, Lc. lactis ssp. lactis and LF 40 cultures were 0.65, 0.64 and 0.64% respectively. The corresponding values for lactic counts were 98 X 10^4 104 X 10^4 and 113 X 10^4/g. The yeast and mold counts in curd rice prepared by using Lc. Lactis ssp. lactis and LF 40 were less than 100/g and samples were well accepted upto 3 days of storage at 37°C, thereafter the yeast and mold counts increased and the acceptability decreased. In case of curd rice prepared by using yoghurt culture, the yeast and mold count was less than 100/g upto 5 days of storage and the product was well accepted upto 5 days of storage at 37°C. Thereafter the product was less accepted due to increased acidity and yeasty flavour.

All the curd rice samples irrespective of culture used, stayed well upto 8 days when stored at 5°C.

The use of yoghurt culture resulted in production of longer shelf life curd rice than other lactic cultures tried. Hence yoghurt culture was selected for further studies.

Effect of Spices on Shelf Life of Curd Rice

Seasoning of curd rice increases the acceptability of the product. Generally mustard seeds, coriander leaves, curry leaves; green chilies are added as seasoning materials in curd rice production. In the present study, attempts were made to incorporate these materials in curd rice. The seasoning materials were added to culture added milk for uniform distribution of seasoning materials. The seasoned and yoghurt culture added milk was added to cooked rice in the ratio of 0.7: 1.0 and incubated at 30°C for 14 – 16 hours after packing in polyethylene pouches, for curd rice production. After incubation period, the curd rice samples were stored at 30°C to study the effect of seasoning materials on the shelf life of curd rice. It was observed that the product was well accepted upto 4 days of storage, whereas the curd rice prepared without the seasoning materials had a shelf life pf 5 days under similar conditions of storage.

Effect of ginger on shelf life of curd rice

Attempts were made to incorporate wet ginger at different levels to evaluate its effect on sensory quality and shelf life of the product. The ginger was chopped in into fine pieces and seasoned along with other seasoning materials and raw milk was added to it. Common salt was @ 1% of milk taken. The seasoned milk was then boiled for 2 – 3 minute. This enabled the extraction of flavour and other soluble components from ginger into milk. The milk was then cooled to room temperature, inoculated with yoghurt culture @ 1% of milk taken. The inoculated milk mixed with cooked rice, packed, incubated and stored as mentioned earlier. It was found that the ginger added curd rice had a shelf life of 7 days at 30°C storage.
and 12 days at refrigerated temperature (4 – 6°C). The acidity and water activity of fresh curd rice were 0.54% LA and 0.994 respectively. The corresponding values for curd rice at the end of 7 days of storage at 30°C were 0.72% and 0.992 respectively.

The ingredients required for producing 100 kgs of curd rice is given below

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Quantity (Kgs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>09.30</td>
</tr>
<tr>
<td>Water</td>
<td>49.00</td>
</tr>
<tr>
<td>Milk + culture</td>
<td>40.00</td>
</tr>
<tr>
<td>Salt</td>
<td>01.00</td>
</tr>
<tr>
<td>Green chilies</td>
<td>00.30</td>
</tr>
<tr>
<td>Coriander leaves</td>
<td>00.30</td>
</tr>
</tbody>
</table>

The plain curd rice was analyzed for its chemical composition and the results are presented below

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>84.96</td>
</tr>
<tr>
<td>Protein</td>
<td>01.90</td>
</tr>
<tr>
<td>Fat</td>
<td>02.19</td>
</tr>
<tr>
<td>Ash</td>
<td>01.03</td>
</tr>
<tr>
<td>Carbohydrates (by difference)</td>
<td>09.92</td>
</tr>
<tr>
<td>Total solids</td>
<td>12.04</td>
</tr>
</tbody>
</table>

The project was initiated to identify the hurdles for large scale production of curd rice. The technology for production of curd rice has been standardized. The culture and natural preservatives like ginger have been identified as probable hurdles in curd rice production. Since water activity of curd rice sample was found to be in the range of 0.992 – 0.994. It was not considered as hurdle since this range of water activity supports the growth of microorganisms.

**Jowar (Sorghum) Based Products**

**Porridge: Milk Solids and Sorghum based porridge**

Porridges are the major foods in several Asian and African countries. They are either thick or thin in consistency and carry different local names. Thick porridges are called uguli (Kenya, United Republic of Tanzania, and Uganda), to (Burkina Faso, the Niger). Thin porridges are called uji (Kenya, United Republic of Tanzania), ogi or koko (Nigeria, Ghana), rabri (India). In an attempt to produce milk solids & sorghum based porridge, the present study was initiated. Popped sorghum and roasted sorghum floors were blended separately with milk powders (SMP/WMP) at 20, 30& 40%. Sugar at 17% was added in all the trials. The mixes were fed to domestic pasta (Chakli) maker at appropriate moisture content and thus the obtained products were Tray and Vacuum tray dried (700 Hg vacuum) at 55°C and 75°C separately, to a final moisture content of 4%. The dried product was ground into porridge mix, with which porridge was prepared by cooking with milk for 5 min. The porridge was subjected to sensory evaluation by a panel of judges on 9 point Hedonic scale. The vacuum tray dried porridge with the
formulation of Popped Sorghum:WMP:Sugar in 8.5:2.3:1.0 ratio scored higher score, in comparison to other formulations, in terms of appearance and overall acceptability scores. The studies showed that sorghum can effectively be used with milk solids to make an acceptable porridge.

Extruded breakfast food: Milk solids - Sorghum based extruded breakfast food

Extrusion is being increasingly used for the manufacture of a variety of snack foods. In this process, the cereals are cooked to high temperature for a short time. During the process, starch is gelatinized and protein is denatured, which improves their digestibility. Anti-nutritional factors that may be present also get inactivated. Microorganisms are largely destroyed and the product's shelf-life is thereby extended. The products can also be fortified easily with additives. So far, sorghum extrusion products have not yet been produced on a commercial scale. An attempt was made to produce milk solids-sorghum based extruded breakfast food. Popped sorghum and roasted sorghum flours were blended separately with milk powders (SMP/WMP) at 20, 30& 40%. Sugar at 8% was added in all the trials. Temp of
extrusion was kept constant at 120°C. The extrudates were tray dried to final moisture content of 6% and the expansion ratio was in the range of 1.80-2.15. The breakfast food was subjected to sensory evaluation by a panel of judges on 9 point Hedonic scale. The extruded food with the formulation of roasted Sorghum:SMP:Sugar in 10:6:1 ratio scored higher score, in comparison to other formulations, in terms of appearance and overall acceptability scores. Proximate composition of the product was Protein-16.8%, Fat-2.8% and Carbohydrates and sugars-74.3%. It can be concluded that sorghum can effectively be used with milk solids to make an acceptable extruded breakfast food.

A Dahi Based Traditional Food Product

Kalan

Kalan is a popular traditional dahi based product from Kerala. The product has commercial potential as it has a better shelf-life than other dahi based products. Therefore, technology for production of kalan with consistent textural quality, desired organoleptic properties and long shelf-life has been developed.

In the traditional method of preparation of kalan, dahi is concentrated by boiling it along with turmeric and curry leaves. Cooked vegetables (elephant yam and unripened banana colloquially known as nentra bale), coconut paste and spices are added to the concentrated dahi and boiled further. The consistency of kalan could vary from free flowing to the semi solid with suspended vegetable pieces. The flavour of the product is contributed by fenugreek, turmeric and curry leaves. The product on storage at room temperature becomes unacceptable after 3-5 days due to flavour deterioration and mould growth.

Traditionally, kalan with a high degree of sourness is preferred. To prepare such a product, the conditions necessary for the required acid development such as the type of culture and time and temperature of incubation were standardized. Dahi with an acidity of 0.8-1.1% lactic acid was used. On concentration the acidity increased to 1.9-2.6%. Dahi concentrated with curry leaves and turmeric masked the sourness to some extent and gave a pleasant aroma.

Quantity of vegetables, spices and condiments required per unit weight of concentrated dahi was standardized. The vegetable pieces, previously shallow fried in ghee with pepper powder, turmeric and salt, were subjected to pressure cooking.

The cooked vegetable pieces, paste of coconut and condiments were added to the concentrated dahi and the mixture was boiled for 5 min. The seasoning with mustard, red chillis and curry leaves in coconut oil was done at this stage.

The major factor affecting the storage quality of this product was found to be the growth of yeast and mould. Sterilization of the product to enhance keeping quality resulted in undesirable colour development and loss of flavour. Packaging of the product in flexible pouches followed by controlled heating (below 100°C) increased its shelf-life to more than three months. Results indicated that retort processing could be useful for commercializing this product.

Conclusion

The dairy plants are looking for newer products for diversification and value addition. There is scope for the dairy plants to introduce newer products in the health food, convenience food and ready to eat segments for capacity utilization and value addition.
Current R & D in Value Added Dairy Products

DR. G. R. PATIL AND DR. R.R.B. SINGH
NDRI, Karnal-132 001

Introduction

Changing demographics and life styles today drive food consumption trends. Food is often consumed away from home thereby increasing the use of processed foods. Change in the traditional family structure with household becoming smaller and the increase in the percentage of adult women working have very significantly impacted food preparation and consumption patterns. Consumers are outsourcing food preparation thus emphasizing the need for prepared foods very often in the form of convenience foods. Consumer preferences are also changing. Today they want not only palate and variety but are equally concerned for safety and health issues. Discerning consumers therefore offer far greater challenge for product development and marketing. The need for value addition is being felt all the more and would be cutting edge for the growth of dairy industry in the future. In the face of this emerging scenario, the challenge for tomorrow’s dairy industry will be more exciting and revolve around value addition in terms of new product formulation, shelf life extension using newer preservation technologies, convenience and novel packaging systems. The product portfolio that need to be addressed to would particularly include the exciting range of Indian dairy products with established market and also new range of functional dairy foods viz. neutraceuticals, mood elevating and athletic drinks.

New Product Formulation

Product development involves manipulation of the chemical constituents of food and ingredients to maximize the positive sensory perception by the consumers. Products that contain various combinations of milk components are available in traditional widely used forms. They may include various forms of liquid milk, dried milk powder, butter, cream, ice cream and host of such popular products. Essentially, the three major milk components i.e., milk protein; milk fat and lactose form the basis of development of such products. These ingredients have also found wide applications in non-dairy food sector. Milk fat has found application in chocolate industry as it is compatible cocoa butter and contributes not only to the desired continuous fat phase but also to smooth flavour and texture of milk fat. Caramel flavour is best developed from sweetened condensed milk. Proteins, especially casein, enhance moisture retention by candy. Hydrolyzed milk proteins act as whipping agents in many food formulations. Milk powders are known to improve crust, colour and structural strength of cakes. Whey powders improve tenderness and shortness. Milk proteins, in general, are added to cookies and biscuits to improve its nutritional value as it contains significant amount of essential amino acids that are deficient in wheat / soy flour. Milk proteins in its various forms such as caseinate, co-precipitates, milk proteins concentrates, hydrolysates etc, are being increasingly utilized as fillers, binders and extenders in many comminuted meat formulations as they offer excellent functional properties like solubility and dispensability, opacity, acid stability, water holding, fat binding, viscosity, gelation, heat stability and emulsion stability besides nutrition.

While the demand for such food applications of dairy products for value addition will continue to grow, the dairy market of the future will throw up new challenges. While a section of consumers, particularly domestic, will demand low priced products others would be willing to pay a premium for quality and uniqueness. The challenge for the dairy industry would be to identify the segmented consumption pattern and develop tailored products.
Another challenge would be to design low fat, low cholesterol, low calorie foods without sacrificing taste and mouth feel, the demand for which is likely to grow many folds.

**Shelf Stable and Convenience Foods**

Processed foods become unacceptable after a finite time interval. This time from production to unacceptability is usually designated as shelf life. The product shelf life is controlled by three factors:

- **Product characteristics**
- **The environment to which product is exposed during distribution.**
- **The properties of the package.**

The loss of product life is attributed to spoilage resulting from microbial, chemical, biochemical and physical changes that occur during storage of the product. While traditional preservation techniques viz., sterilization, freezing, chilling and fermentation have been able to prolong shelf life of the processed dairy products, the trend is now shifting to shelf stable foods i.e. foods that are not perishable at room temperatures. Processed food products could be shelf stable if they are preserved by thermal sterilization, contain permissible preservatives, are formulated as dry mixes or processed to reduce water activity. With more and more emphasis being given to minimally processed foods, future dairy industry will have to focus on technology, which uses optimization of several preservation parameters at low intensity rather than a single parameter at high intensity. Hurdle technology could be an area, which needs extensive investigation to develop new shelf stable foods of dairy origin.

Convenience, ready to reconstitute and ready to eat foods are gaining popularity at a pace never seen before. Though market for such foods are still limited to urban consumers, defense personnel, tourists and caterers, future growth of processed dairy food market will be driven to a significant extent by such products. Convenience foods need not essentially be novelty products. These may be our customary dishes, which are processed and conveniently packaged for long shelf life and thus serve as foods to be consumed away from home. Preservation processes generally employed for such products are either sterilization or dehydration. The severity of heat treatment as employed during sterilization, result in severe damage to nutritional, rheological and sensory properties. There is thus need for developing processes, which can result in milder heat treatment coupled with optimization of other preservation factors to achieve longer shelf life. Development of such technologies particularly for our indigenous dairy products will open new vistas for value addition and export.

**Packaging of Value Added Dairy Products**

Dairy products owing to their higher moisture content are prone to microbial spoilage. Wide array of microorganisms including molds, yeasts and spoilage bacteria have been identified in the processed dairy products. Growth of these organisms often results in production of secondary metabolites causing off-flavour and discolouration in the products. Oxidative changes in milk lipids are the major deteriorative factor in many value added products. Many packaging materials have been developed in the course of time to address to these problems. However, recent innovations in modified atmosphere packaging and active packaging may be extended to further enhance the product quality.

In modified atmospheric packaging (MAP), the gaseous composition of atmosphere is altered to retard the various deteriorative reactions. The change in the concentration of oxygen, CO₂ and inert gases prevent the microbial growth and check various oxidative reactions. MAP technology has been found to improve the shelf life of cheeses, where the growth of undesirable filamentous fungi is inhibited. Fungal contamination of cheese is not only an aesthetic problem of discolouration, but also a question of off-flavour and toxic component production.
Active packaging (AP) is a group of technologies in which package material performs some desirable role other than to provide an inert barrier between the product and the outside environment. The active components are grouped into scavenger, emitter and others and are usually a part of packaging material or placed with food products in the package. The active packaging systems, which may find their application in quality maintenance of value added products, include oxygen scavengers, antimicrobial packaging, antioxidants emitters and humidity buffers. Substantial amount of research has been carried out in developing antimicrobial polymer films containing sorbates for the packaging of cheeses in recent years. The kinetic models have already been developed to understand and monitor the migration of active compounds in packaging systems.

Shelf stable foods can retain their stability only if the processed foods have been packaged aseptically in sterile containers and integrity of the package, which contains those remains intact during storage and marketing. Besides, packaging has to also contend with increasing environmental awareness of the consumers along side new technological developments. New packaging technology, which can deliver safe products in attractive packages to the consumers, will go a long way in ensuring value addition.

Indian Dairy Products

Indian dairy products play a significant role in the socio-economic and religious activities of our population. It is estimated that about 50 to 55 per cent of total milk produced (approx. 42 million tonnes) is converted into variety of Indian dairy products by the unorganized sector (halwais) employing various unit operations viz. heat and acid coagulation, heat desiccation and fermentation (Banerjee, 1997). The market for these products is valued at about Rs.400 billion. The size of the market speaks volumes about the tremendous potential of the sector.

In spite of the fact that the traditional milk products have very high palatable characteristics and nutritional profile, their manufacturing has remained largely confined to small level operations, which is manual. Quality in such operations is dependent on the skill of the halwais. Quality control measures are seldom exercised and the keeping quality of the product is generally poor. The small-scale operations are associated with inefficient use of energy, poor hygiene and sanitation and non-uniform product quality (Patil, 2002). Packaging, labeling, handling and sanitary practices take a back seat.

With a large domestic consumer base and continuous rise in ethnic population throughout the world, there exists considerable growth in demand for these products. The changing global scenario in the post GATT era offers us an opportunity to become a global player to command the ethnic food markets. This will call for process mechanization and necessary sanitary and phytosanitary measures to be taken so that indigenous milk products, which are added with immense value, meet international standards of quality assurance. This will have to be done at massive scale and fast, as failure on this front will lend other developed nations opportunity to market our own products in attractive packages thus establishing a definite edge.

NDRI has done a commendable work in developing a large list of value added dairy products, which are ready for transfer to prospective manufactures (Table 1).
### Table 1: Some of the Value Added Dairy Products Developed at NDRI, Karnal

<table>
<thead>
<tr>
<th>Value added traditional dairy products</th>
<th>Main features of the technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ready-to-reconstitute Kheer mix</td>
<td>A dry mix comprising ready-to-rehydrate rice particles in powdered milk/cream fraction. It can be rehydrated by dispersing in boiling water and cooking for 4 to 5 min before cooling and serving. The product has shelf life of more than six months.</td>
</tr>
<tr>
<td>2. Ready-to-reconstitute Rasmalai mix</td>
<td>The product consists of dehydrated patty and syrup portions prepared by an osmo-air dehydration process. The product has a shelf life of six months at room temperature. Rehydration of patties and syrup mix powder can be accomplished by heating in boiling water for 4 to 5 min.</td>
</tr>
<tr>
<td>3. Ready-to-reconstitute Baundi mix</td>
<td>The product in dehydrated form has been obtained by blending particulated whey protein (PWP), osmo-air-dehydrated sweetened milk solids (SMS), and sugar. It is shelf stable at room temperature. It can be reconstituted within 5 min. by mixing with boiling water.</td>
</tr>
<tr>
<td>4. Herbal Ghee</td>
<td>Cow cream has been processed into herbal ghee incorporating extracts of herb <em>Arjuna terminalia</em> which provides protection against heart diseases, regulates blood pressure and strengthens arteries. The product has colour and flavour similar to the market ghee. Process can be adopted for large-scale production.</td>
</tr>
<tr>
<td>5. Khoa Powder</td>
<td>On reconstitution with water, this can be utilized directly for the preparation of burfi, milk-cake, kalakhand and gulabjamun. Khoa powder packaged in tin containers under nitrogen gas can be stored for up to 10 months at 30°C.</td>
</tr>
<tr>
<td>6. Gulabjamun mix powder</td>
<td>It is formulated from skim milk powder, vanaspati, maida, semolina, baking powder and ground cardamom. Gulabjamun mix powder packaged in metalized polyester PE laminate, without any preservative remains fit for use up to eight months at 30°C.</td>
</tr>
<tr>
<td>7. Rasogolla mix powder</td>
<td>Rasogolla mix powder gives 20% higher yield than that obtained from traditional method. Dried rasogolla mix can be stored without spoilage for about five months at 30°C and for 10 months at 5°C in sealed containers.</td>
</tr>
<tr>
<td>8. Instant kulfi- mix powder</td>
<td>It is formulated from milk fat, milk solids-not-fat, sucrose and isabgol husk. This product has a shelf-life of 7 months at 30°C in tin cans. The shelf-life can be extended up to 10 months with the addition of butylated hydroxy anisole and nitrogen gas flushing.</td>
</tr>
<tr>
<td>9. Instant kheer mix</td>
<td>The two-phase product comprising powdered milk fraction and particulate (instant rice) fraction is packaged bag-in-bag, a small polyethylene pouch of rice being carried in a bigger bag containing the powder. The mix packaged in metalized polyester/LDPE pouches has shelf life of at least six months at 37°C.</td>
</tr>
<tr>
<td>10. Long life paneer</td>
<td>An innovative approach employing in-package sterilization directed at heat/acid coagulation of concentrated milk coupled with texturization has been conceptualized. While extending shelf life at room temperature, it permits conservation of milk solids without loss of whey.</td>
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</tr>
<tr>
<td><strong>11.</strong> Ready-to-serve Paneer Curry</td>
<td>The product developed based on hurdle technology consists of gravy and paneer. The paneer curry has shelf life of one month at 30°C and more than 3 months at 15°C.</td>
</tr>
<tr>
<td><strong>12.</strong> Extending shelf life of ghee</td>
<td>Different species of lactic acid bacteria when cultured in the cream, produces metabolites, meant finally for making ghee with good flavor and palatability, also with extended shelf life of 5 to 8 months.</td>
</tr>
<tr>
<td><strong>13.</strong> Malted milk food</td>
<td>Process technology for manufacture of malted milk food in continuous manner using conventional spray drier has been standardized. The spray dried malted milk food packaged in metalized polyester laminate pouches has shelf life of more than 1 year at 25°C.</td>
</tr>
<tr>
<td><strong>14.</strong> Goat milk cheddar cheese</td>
<td>An appropriate technology has been developed for the manufacture of Cheddar type cheese from goat milk. Flavour and acceleration in ripening rates are the main features of the technology.</td>
</tr>
<tr>
<td><strong>15.</strong> Probiotic Edam Cheese</td>
<td>The technology has been standardized for the successful incorporation of <em>Bifidobacterium bifidum</em> in Edam cheese. The cheese, as carrier of probiotic organisms has enhanced nutritional and principal probiotic attributes.</td>
</tr>
<tr>
<td><strong>16.</strong> UF Shrikhand</td>
<td>Coagulated skim milk concentrated by UF using mineral membrane module recovers whey proteins in the form of retentate and later by addition of plastic cream and sugar we can make Shrikhand.</td>
</tr>
<tr>
<td><strong>17.</strong> Cheddar Cheese Flavour Base (CCFB)</td>
<td>CCFB is a cheese flavourant, which can be used for flavouring processed cheese, spreads and other food products requiring cheesy flavour. It is cheap and convenient substitute for matured cheddar cheese. The shelf-life of the spray dried CCFB packed in metalized polyester laminate is more than 8 months at 15°C.</td>
</tr>
<tr>
<td><strong>18.</strong> Acidophilus Milk</td>
<td>It is a sour milk product that has been allowed to ferment under conditions that favour the growth and development of a large number of <em>Lactobacillus acidophilus</em> organisms. The product contains 2000 – 3000 million viable cells/ml, which possesses a satisfactory therapeutic effect.</td>
</tr>
<tr>
<td><strong>19.</strong> Nutritionally improved infant formulation</td>
<td>Various formulation have been developed as per the nutritional requirements of different categories of infants, that may have been born normally or pre-matured or with in-born physiological disorders. § Formula for full term infants§Lactose hydrolyzed infant formula§ Bifidus containing infant formula§ Pre-term infant formula</td>
</tr>
<tr>
<td><strong>20.</strong> Low lactose powder</td>
<td>Ultrafiltration technology was employed for the manufacture of low lactose powder to help the lactase enzyme deficient world’s population. The product can be kept for about 9 months at room temperature. The benefit of this technology is that no chemical is added to reduce the lactose content in the powder with negligible loss of biologically available lysine.</td>
</tr>
<tr>
<td><strong>21.</strong> Low fat spreads</td>
<td>This has been developed to provide a low-fat, low-cholesterol spread that is acceptable in all respects including spreadability at refrigeration temperatures and sensory characteristics at an affordable cost.</td>
</tr>
</tbody>
</table>
22. Ready-to-reconstitute mushroomwhey soup powder

Since whey proteins are rich in sulfur containing amino acids, the supplementation of whey proteins would increase the protein quality of the soup. The soup can be easily reconstituted after boiling for 2 min in water. The soup powder has a shelf-life of 8 months at 30°C.

23. Filled milk paneer

Vegetable oils/vanaspati is blended with skim milk. The resulting product is quite acceptable and cheaper. The yield of filled milk paneer is about 20-22%.

24. Lactose

Whey utilization for lactose manufacture not only accrues economic benefits but also helps alleviate the BOD in effluents. The process using membrane technology yields up to 99% pure lactose with a recovery of up to 70%.

**Dairy Products as Health Foods**

The availability and increasingly high profile of functional foods provide consumers an opportunity to consume dairy products with health benefits beyond those of traditionally formulated products. Neutraceuticals, a term generally being used for such foods, refer to functional foods that provide benefit beyond basic nutrition and may prevent disease and/or promote health. Dairy ingredients combine functionality with nutritional qualities that make them very attractive for consumers. Many milk components have excellent application opportunities in neutraceutical products (Table 2).

**Milk Proteins**

Proteolytic products of several food proteins have shown presence of physiologically active peptides. These biopeptides are known to exhibit opiate (morphine like), immunomodulating, antihypertensive and mineral utilization boosting effects. Such bioactive peptides remain dormant in the inert state in the original protein sequence and may be released by enzymic hydrolysis. Milk proteins (casein and whey proteins) when hydrolyzed by gastric and pancreatic enzymes in non-cultured milks and peptidase activity of lactobacillus bacteria in cultured milks, result in release of such peptides (Tomar and Prasad, 2002).

Among the two major groups of milk proteins, casein components as such do not have any specific biological activity but casein micelles are good carrier of trace elements viz. calcium and phosphate. The major whey protein, b-lactoglobulin enhances the retinal uptake in the intestines. Bovine colostrum, which contains nearly 100g/l of immunoglobulins provide passive immunity for the neonate. Lactoferrin, a major iron binding protein is known to efficiently deliver iron for intestinal absorption and also function as a growth factor for human lymphocytic cell lines. Lactoferrin, lactoferricin (derived from lactoferrin) and lysozymes are highly effective against a host of bacteria including pathogenic strains but not against many adventitious microorganisms including Bifidobacterium. Besides, milk also contains certain protective proteins, which are known for defense mechanism against infections (Sabikhi, 2000). Lactoperoxidase, a component of milk and whey products is known to exhibit antibacterial properties and is being used as a cavity-inhibiting ingredient for toothpaste.

**Probiotics and Prebiotics**

Probiotic foods are those foods which carry live mono or mixed culture of microorganisms which when consumed by humans, beneficially affects the host by improving the properties of intestinal microflora by selectively stimulating the growth and/or activity of one or a limited number of naturally present or introduced bacterial species in the colon, leading to improved host health. A prebiotic affects the host beneficially by selectively stimulating the
growth and/or activity of one or a limited number of naturally present or introduced bacterial species in the colon. Both probiotics and prebiotics are often used in combination to achieve symbiotic affects (Walzem, 1999).

Fermented foods are recognized as most healthy diets and carrier for microbes that take up residence in the intestine when consumed. The most commonly utilized probiotics in dairy products are lactobacilli and biofidobacteria. Several new dairy product formulations are being developed with such microbes which when consumed offer potential health benefits viz. increased resistance to infectious diseases - particularly of the intestine, decreased duration of diarrhea, reduction in blood pressure, reduction in serum cholesterol concentration and allergy, stimulation of phagocytosis by peripheral blood leucocytes, modulation of cytokine gene expression, adjuvant effects, regression of tumors, reduction in carcinogen products, increased tolerance to lactose in lactose intolerant population etc.

Whey carbohydrates are considered excellent prebiotics although whey proteins and peptides are also known for their probiotic actions. Whey proteins are particularly very effective when intestinal competence is challenged such as during cancer treatment. Novel dairy health foods, therefore offer excellent scope for combining a variety of elements such as probiotics, immunoglobulins and prebiotics that could be administrated to human population for achieving desired health benefits.

Table 2: Possible Commercial Utilization of Individual Milk Components

<table>
<thead>
<tr>
<th>Compounds</th>
<th>Properties</th>
<th>Uses</th>
</tr>
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<tbody>
<tr>
<td>αlactoglobulin</td>
<td>Nutrition, carrier of retinal and fatty acid</td>
<td>Infant formula, Humanized milk</td>
</tr>
<tr>
<td>β-lactoglobulin</td>
<td>Gelling, solubility and nutrition</td>
<td>Restructured meat and fish</td>
</tr>
<tr>
<td>Immunoglobulins and bovine serum albumin</td>
<td>Anticancer, Enhanced immunity</td>
<td>Cancer prevention and treatment, diet for person who are HIV positive, have AIDS</td>
</tr>
<tr>
<td>Lactoferrin</td>
<td>Antibacterial</td>
<td>Infant formula, health foods</td>
</tr>
<tr>
<td>Lactoperoxidase</td>
<td>Anticaries, important component of LP system, antimicrobial</td>
<td>Tooth paste, Tumor therapy, Cosmetics</td>
</tr>
<tr>
<td>Whole protein coprecipitate</td>
<td>Balanced amino acid profile</td>
<td>Nutritional beverages</td>
</tr>
<tr>
<td>Whey protein isolates</td>
<td>Functional performance</td>
<td>Egg substitute in bakery industry, Fat replacer in ice cream and frozen dessert</td>
</tr>
<tr>
<td>Protease- peptones</td>
<td>Immunomodulatory</td>
<td>Prebiotic foods</td>
</tr>
<tr>
<td>Immunoglobulin</td>
<td>Provide passive immunity</td>
<td>Cancer prevention</td>
</tr>
<tr>
<td>Casein (acid)</td>
<td>Functional properties</td>
<td>Glue, paints, leather, rubber, textile, plastic industries</td>
</tr>
<tr>
<td>Casein (rennet)</td>
<td>Stretch properties</td>
<td>Analogue cheese preparation</td>
</tr>
<tr>
<td>Whey protein concentrate (WPC)</td>
<td>Special performance, solubility, gelling, emulsifying, foaming agent</td>
<td>Value added products, health beverages and egg substitute in bakery products.</td>
</tr>
<tr>
<td>Whey protein hydrolysates</td>
<td>Nutritionally rich, reduce allergicity, solubility over a wide range of pH</td>
<td>Infant health foods, geriatric foods, Athletic drinks</td>
</tr>
</tbody>
</table>
Lactulose  Bifidobacteria enhancement, laxative, oxygen uptake, ammonia reduction in blood  Infant formula, laxative, diet for athletes

Lactitol  Bifidobacteria enhancement, noncaloric sweetener  Infant formula, chewing gum

Lactobionic acid  Bifidobacteria enhancement and other health related uses  Various food applications

Oligosaccharides  Bifidobacteria enhancement  Infant formula, baby foods, yoghurt, fermented dairy products

Mixture of salts recovered from whey UF permeate  Flavour, nutrition, low sodium content  Table salt substitute, health drink

**Conclusion**

Rising population coupled with increasing urbanization, education and awareness have stimulated a trend wherein consumers are not only conscious about taste but also safety, attractiveness and convenience of foods. In future, there will be increased demand for higher added value and product performance, creating greater challenges for new product development. On domestic front, affluent middle class is growing considerably. This will be the target group for most of the dairy products, especially for higher added-value dairy products. Post WTO scenario provides India with an opportunity to market their products in other parts of the world, particularly to more than 150 million non resident Indians settled all over the world. Tremendous export potential therefore exists for unique traditional milk products. Potential for producing healthful functional foods incorporating valuable dairy ingredients in existing and new product formulations will also have to be exploited. This calls for dairy scientists and entrepreneurs to adopt a holistic approach to product development encompassing new dimensions of value addition, unfolding newer processing know how, international quality and safety standards as also global environmental practice.

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The dairy industry has become a complex business. In the old days, it was mainly a matter of delivering basic milk, cheese and butter products to a limited area. But now, dairy manufacturers are providing a sophisticated and ever-changing range of products to customers all over the world. Success in the industry hinges on market insight and the ability to move very quickly when consumer demands and trends change. This requires to produce greater variety of products in fewer plants, more cost effectively at higher standards of quality and hygiene, with minimum impact on the environment. Consumers are increasingly demanding high quality foods that are wholesome, nutritious, and safe. Processors are aware that high quality milk results in increased yields of manufactured products with greater shelf life and improved organoleptic properties.

These changes in the dairy industry are driving changes in the approach to, and rapid changes in, the technology used in cleaning and sanitation. A thorough knowledge is essential when changing the technology and the methodology. Both alkaline and acidic single stage cleaning, cleaning and disinfecting in the same step and advances in disinfection technology as well as CIP methodology are the changes being driven.

Milk hygiene includes all the necessary measures to guarantee food which is clean, safe, sound and wholesome (WHO/FAO). The precautionary measures concern all production stages, from storage, transport, processing, packaging, storage and sale or delivery of milk products to the consumer. Milk production is inextricably linked to the environment.

Good quality raw milk is required to make good quality dairy products. Once raw milk is defective, it cannot be improved during processing, and defects often become more pronounced. Therefore it imperative that raw milk be produced and handled, from farm to plant, under conditions that do not reduce its quality or consequently, the quality of the product.

In March 2003, just prior to the Third World Water Forum in Kyoto, Reuters reported that the United Nations published a report compiled by the World Water Assessment Program at UNESCO in which the following claims were stated. “There is not sufficient water for adequate sanitation and hygiene for about 40% of the population” and “By 2050 water scarcity will affect between 2 billion and 7 billion people. This assumes a projected total (population) of 9.3 billion”. There are many other reports which could be quoted. However, what is clear is that water will become a scarce commodity and that those industries that adopt program's now to reduce the amount of water used in production, will be the most successful in business when these shortages will occur. This will also apply to the dairy industry.

Other changes that are/can happen in the dairy industry are the consolidation of smaller dairies into larger dairies. In Indian context, it will be interesting to see the path it will follow. One of the reasons for this is to lower the cost of production by increasing the throughput. The implication from the cleaning perspective is that it needs to be done faster and to the same or to the higher standard. Shelf life too is becoming important as certain dairies try to maximize the efficiency of supply lines by delivering more, less frequently.

“This drives the need for higher standards in cleaning & sanitation”.
Also the demand for natural products by consumers as the awareness of a healthy diet has increased. The requirement to reduce or exclude chemical preservatives is growing and an increase in the legislation governing the production of foodstuff is driving the higher standard in hygiene. Care for the environment is an umbrella for most of these and also drives the need to control or reduce the amount of energy used to run the factory.

To summarize the industry needs to have a product on the shelf in the

• In the shortest period of time
• Maintaining the highest quality & hygiene standards
• Ensuring the environmental norms is fully complied.

“Formulated Chemicals- An efficient Solution”

As in all modern business practices a need to understand the costs of making these changes is required. For example, it is believed that in CIP the major input cost is the chemicals used. However, an analysis of the cost shows that they are made up of water (both incoming & outgoing effluent), energy used to heat the water and or the system, energy to pump the fluids, lost time in production (if the plant is producing more product), labour costs involved in CIP ongoing maintenance costs of the plant, depreciation of the CIP plant and processing plant and finally chemicals costs. For any of the new technologies to be successful, the overall costs needs to be same or reduced.

In traditional CIP program there are seven steps

• Water Rinse
• Alkaline Detergent
• Water Rinse
• Acidic Rinse
• Water Rinse
• Disinfectant Cycle
• Potable Water Rinse – When a chemical Disinfectant is used!

By combining the disinfectant and the acidic rinse, or removing the acidic rinse, time, and water savings can be achieved! With the latest technology (and those that are driven primarily by water savings), the CIP cleaning is being achieved in only three steps, namely:

• Water Rinse.
• Detergent and Disinfectant Cycle.
• Potable Rinse- The last rinse is used only to remove the chemical substances and is being optimized to ensure minimal water usage.

The cleaning and disinfection chemistry that is applied will depend on the soils present. In dairies, when the soiling is not heat-treated and the viscosity of the product is fairly low, acidic cleaning and disinfection has been developed and is one of the new technologies that has been implemented. This technology uses emulsification as cleaning mechanism and surface active disinfection. The leading edge technology in this field uses a disinfectant that is not chemically consumed in the disinfection process. This disinfectant is easily recoverable and reusable leading to the further reductions in water usage and chemicals applied. The impacts of this technology are: less water used (cleaning & disinfection combined), less energy consumption and lower temperatures, as the temperature of process is below 45degC, much lower than the traditional temperatures used. A further advantage, which is often overlooked, is fewer chances of something going wrong or being left out.

In the soils which are heat-treated, the soiling that is left after processing is far higher
in mineral content and has denatured proteins. In order to reduce the amount of water used in cleaning and the implied reduction in steps in cleaning, the acidic rinse, which is needed to remove the mineral content of the soil, can be replaced with an additive package to Caustic. This package allows less caustic to be used as the removal of the organic soiling is enhanced and the minerals are removed by sequestration at high pH. The net effect is the acidic step can be removed, leading to water and time savings. An additional benefit is that the treated effluent will have less sodium in it due to the lower concentration of caustic being used. This means that the treated effluent is more suitable to be used in agriculture irrigation, an important factor as water shortages grow. The overall benefits are less water used, less time, lower effluent costs and the ability to use the neutralized effluent for irrigation. This technology can also be applied to viscous, high fat or high protein containing non-heat treated soils. The causticity is lowered, the need for acidic descaling reduced or eliminated and the temperature of the clean reduced.

**Caustic and Formulated Chemicals – A comparison**

Industrial grades of potassium and sodium hydroxide are used for cleaning due to economy and dissolving power. **However, caustic has four major disadvantages**

- It is highly corrosive to all non-ferrous metals. It will quickly remove galvanise and paint. It will severely pit aluminum. It will expose steel surfaces to rust.
- It is quite difficult to rinse, making it necessary to use large amounts of water for rinsing, to use an additive, or to use an acid for neutralization.
- Its use in hard water will cause severe build-up of mineral scale and thereby requiring excessive amounts of acid to remove scale.

An example

*Action of formulated cleaning solution*

![Figure 1](image)

**Figure 1**

Action of the cleaning solution with only caustic

This is how a metal surface will be seen if observed under a microscope. When we use only caustic solution as a cleaning media the solution will form bigger size droplets leading to improper removal of soil.

The same surface when cleaned with formulated detergents the cleaning solution will form smaller solution droplets, in turn giving better penetration of the cleaning solution with the surface to be cleaned. This assures complete removal of soil from the surface to be cleaned, assuring a clean and hygienic surface.
Formulated Detergents Typically Consists of

- Surfactants for emulsifying, wetting, and penetrating
- Sequesterants for binding together with metal ions and sequester so as to prevent them from reacting with other compounds.
- Builders for neutralizing water interference, chelating of inorganic oils, and saponification of natural oils.
- Additives for corrosion inhibition, anti-redeposition, and rinsing.

Advances in Disinfection Techniques

It is appropriate to look at some of the advances in disinfection techniques. The traditional method of using steam is very effective. In terms of the drivers of change in the dairy industry, its use is both time consuming and energy intensive, as the plant needs to be heated to, for example, 85 deg C for at least 20 minutes. Often the plant then needs to be cooled before filling with the product being produced. The other industry standard is peracetic acid, which is a very good disinfectant. The issue with its use is the limited cycles of recovery (at best 3 to 4) that can be achieved, which means that the volume of water used for disinfection is very high. In cases where alkaline cleaning is needed, the same disinfectant technology referred to in the non-heated soil cleaning above, can be combined with acidic rinse. The water used for this process is limited to the water lost in phase changes and the routine occasional renewal of the tank. Dependent on how well the CIP station is both designed and set up, the water used can be less than 20% of that used for normal per-acetic acid disinfection and substantially lower than hot water disinfection. Added advantages are that is performed at ambient temperature leading to lower use of energy, time savings as acidic de-scaling or rinsing is combined with the disinfectant. The temperature of the plant can be maintained at the temperature of the production.

Open Plant Cleaning

The focus up to now has been on water savings in CIP. This concept can be also applied in open plant cleaning. Technology has been developed for reducing the amount of rinse water needed to clean plants. Products are available which increases the retention time of the applied chemical by up to six times and to reduce the amount of water used for rinsing by 6-8 times. The additional clinging time will yield better cleaning results as contact time has increased, thus reducing repeat applications, where needed. This leads to savings in water and time. The most remarkable aspect however is the saving in water for rinsing and the increase in hygiene standards.
With a focus on reduction in use of water in cleaning and disinfection in the dairy industry, it has been demonstrated how some of the advances in chemical technology are being applied to the dairy industry. It has been shown that these technologies are being drive by market forces on the industry. Whilst the chemical costs have been increased, the overall costs of cleaning and disinfection can be reduced and in some cases dramatically reduced, giving the other benefits of reduced water consumption, more processing time and higher hygiene standards.

This paper would not be complete without a mention of some of the other techniques and methodologies being introduced in the dairy industry. They are driven in principle in the same way as the need for water reduction is driving the chemical technologies. However, only the most important aspects of these will be mentioned.

Hazard analysis of critical control points, HACCP, has been in place for a long time. These techniques have been identified the need to have proof of cleaning. When automated systems are used, this becomes even more important. There are a number of systems available that will monitor the CIP station and give details of each CIP clean that takes place. The most important monitoring points are flow rate, temperature and chemical concentration, often measured by conductivity. This technology has been around for some time and is no longer leading edge. However, new technology is now available to, not only monitor the CIP, but diagnose what is happening and make adjustments to the program to ensure that cleaning and disinfection cycles are completed according to the requirements of the procedure laid down in the plant’s HACCP manuals.

These controls are based on computers with programmed artificial intelligence, which record all previously completed cycles, and fine-tune the parameters to optimize the effects of CIP. The computer has the ability to dial in to remote computers to seek expert advise when changes outside the normal parameters are detected, or to seek personal intervention by individual. The technology has also been evolved to monitor the stock of cleaning materials, and to re-order as and when they are needed, or the supplier can use telemetry to monitor the levels of chemicals to optimize when it is best to deliver further stocks. This reduces the stock outs and emergency deliveries taking place to keep plants running.

In conclusion, the advances in cleaning and sanitation technology in the dairy have been looked at. The conclusion that can be drawn is that there is no single advance in these advances in these technologies that is applicable to all factories and plants, let alone CIP stations. However, planning for these changes needs to take place now for existing and new facilities and, wherever possible, for these advances to be put in place to ensure delivery of water savings for the well being of all, better products for consumers and a long term future of the planet.
Application of Quantitative Microbiology for Assuring the Quality and Safety of Foods

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Food microbiology is the study of both beneficial and pathogenic microorganisms in raw and processed foods. One area of food microbiology, predictive microbiology, uses mathematical models to define the growth kinetics of food microorganisms and predict microbial behavior over a range of conditions. Predictive microbiology is used to assess the risks of food processing, distribution, storage and food handling; and, to implement control measures in order to protect the microbiological quality of foods, important for both food safety and product quality.

Ensuring the microbial safety and shelf life of foods depends on minimizing the initial level of microbial contamination, preventing or limiting the rate of microbial growth, or destroying microbial populations. With many foods, these strategies have been practiced successfully for years. However, in the last decade, the incidence of food borne disease has increased, despite the introduction of the Hazard Analysis and Critical Control Points (HACCP) concept and the promulgation of regulations in food safety. The increased incidence of food borne disease is caused by changes in agricultural and food processing practices, increasing international trade in foods, and social changes, which include changed eating habits and increased population mobility.

Microbial Growth in Foods

Microbial load in a food source depends upon the initial level of bacterial contamination as well as environmental conditions (temperature, pH, water activity, preservatives, antimicrobials and the composition of the atmosphere), which influence growth, inactivation and survival in the food. Most studies in food microbiology are concerned with the rapid growth of populations, but in many ecosystems, the survival characteristics of the population also need to be considered. The longevity of bacterial spores and their resistance to harsh conditions are well documented. However, the ability of vegetative cells to resist stressful conditions is increasingly recognized as an important ecologic trait. Attention also needs to be given to relatively slow-growing populations in various situations, e.g., when the shelf life of a product is extended by control of rapidly growing spoilage organisms.

The behavior of food borne microorganisms, be it the growth or death of microbial populations, is based on the time of exposure to environmental factors affecting population development; for example, equivalent kills of bacteria in milk are achieved by low temperature; long time pasteurization (60°C/30 min) and high temperature; short time pasteurization (72°C/15 sec). When populations are in the biogenetic range, the rate at which they develop is determined by factors such as temperature, water availability, and pH applied in food preservation procedures. The extent of microbial growth is a function of the time the population is exposed to combinations of intrinsic food properties (e.g., salt concentration and acidity) and extrinsic storage conditions (e.g., temperature, relative humidity, and gaseous atmosphere).

Different factors assume dominance in different foods and preservation strategies. In many foods, the full preservation potential of a single property is restricted because of considerations related to the esthetic, organoleptic, and nutritional properties of the product. However, several properties or conditions may be combined to provide a desired level of stability. In situations where the preservation strategy is designed to slow the rate of population growth, the effect will always be increased by storage temperature.
Temperature control in processing, distribution, and storage (the cold chain) is crucial to ensure the adequate shelf life and safety of many common foods, including meat, fish, poultry, and milk. Newer technologies, including modified atmosphere packaging and sophisticated products such as sous-vide meals, do not obviate the need for strict temperature control. Indeed, the requirement for vigilance increases with increased shelf life and the possibility of growth of psychrotrophic pathogens over an extended period.

**Role of Kinetic Models in Predictive Microbiology**

Predictive microbiology involves knowledge of microbial growth responses to environmental factors summarized as equations or mathematical models. The raw data and models may be stored in a database from which the information can be retrieved and used to interpret the effect of processing and distribution practices on microbial proliferation. Coupled with information on environmental history during processing and storage, predictive microbiology provides precision in making decisions on the microbiologic safety and quality of foods. The term “quantitative microbial ecology” has been suggested as an alternative to “predictive microbiology”.

The development, validation, and application of predictive microbiology have been extensively studied in the last decade. Most of the modeling studies have concentrated on descriptions of the effect of constraints on microbial growth (rather than survival or death), often using a kinetic model approach (rather than probability modeling) and most often describing the effect of temperature as the sole or one of a number of controlling factors. For example, the temperature dependence model for growth of *Clostridium botulinum* demonstrated a good fit to data, but the authors noted, “Care must be taken at extremes of growth, as no growth may be registered in a situation where growth is indeed possible but has a low probability”.

The emphasis in modeling efforts on temperature (often in combination with other factors) may be justified, given its crucial role in the safe distribution and storage of foods. Surveys carried out over several decades in the United Kingdom, United States, Canada, and Australia point to the predominant role of temperature abuse in outbreaks of foodborne disease.

**Role of Growth and No Growth Interphases**

Because growth of pathogenic bacteria in foods always increases the risk for foodborne disease, defining the conditions at which no growth is possible is of considerable practical significance for food manufacturers and regulators. Bacterial growth/no growth interface models quantify the combined effect of various hurdles on the probability of growth and define combinations at which the growth rate is zero. Increasing the level of one or more hurdles at the interface by only a small amount will significantly increase the probability of “fail safe” events and decrease the probability that a few cells in the population will resolve the lag phase and begin to grow (a “fail dangerous” event). The growth/no growth interface also have great physiologic significance because at that point biosynthetic processes are insufficient to support population growth, and survival mechanisms are in place.

A procedure to derive the interface was proposed by Ratkowsky and Ross; it employs a logistic regression model to define the probability of growth as a function of one or more controlling environmental factors. From this model, the boundary between growth and no growth, at some chosen level of probability, can be determined. The form of the expression containing the growth limiting factors is suggested by a kinetic model, while the response at a given combination of factors is either presence or absence (i.e., growth/no growth) or probabilistic (i.e., the fraction of positive responses in n trials). This approach represents an integration of probability and kinetic approaches to predictive modeling.
Specific Quantitative Models

The incorporation of predictive models into devices such as temperature loggers has been described for E. coli and Pseudomonas, as has the development of expert systems from predictive modeling databases.

Based on the work carried out in our lab, we have also been able to develop the quality and safety prediction models for indigenous milk products like paneer. The models are based on the Cobb-Douglas equation and can predict the spoilage of the product based on the total viable counts, moisture and pH. The modifications of the model have also been developed by incorporating the proteolytic and lipolytic microflora.

The model can also predict the product safety for the common food pathogens such as Staphylococcus aureus and Escherichia coli. The attempts are currently going on to convert these models in to Computer based applications by developing the necessary software under artificial neural network (ANN) modeling.

It is strongly felt that the existing quantitative information on microbial growth, survival, and death, if properly applied, would have an immediate impact on the incidence of foodborne disease in the world. Even without the synthesis of data into mathematical models, simply logging the temperature history of food processing, distribution, and storage operations would provide much useful information. For loggers with appropriate software, the temperature profile may be interpreted in terms of microbial growth. However, the interpretation must be based on an informed analysis of the temperature history by a trained operator.

An alternative is the development of in- or on-package temperature tags as recommended in the U.S. Food Safety Initiative draft document Food Safety from Farm to Table. With temperature tags, informed interpretation is not required because abuse is indicated directly by the tag response. The time/temperature tags available are based on physical or chemical changes that follow Arrhenius kinetics. While these may give a reasonable approximation of microbial growth in the normal range, the deviation of microbial responses becomes increasingly large as conditions move from normal to stressful. Similarly, the possibilities of developing a universal indicator are based on a relationship that describes the maximum specific growth rate of a continuum of organisms from psychrophiles to thermophiles in terms of Arrhenius kinetics.

Pathogen Modeling

Mathematical models used in predictive microbiology are simplified, imperfect expressions of the numerous processes that affect bacterial growth in foods. They are classified as primary, secondary and tertiary.

Primary Models

These models reflect changes in microbial load as a function of time. Primary models typically have parameters based on cellular mechanisms that affect bacterial behavior, but since the total number of such cellular processes has not been defined, the majority of such models are empirical. If all cellular processes could be defined and incorporated into one model, the resulting model would be too complex for routine use.

Secondary Models

These models predict changes in primary model parameters based on single or multiple environmental conditions. An example of a secondary model would be the growth of a microorganism as a function of temperature.
Tertiary Models

These models express secondary model predictions in a primary model using spreadsheets and computer software. There are several pathogens modeling programme that have been developed as user-friendly software. However, the accuracy of these predictions cannot be guaranteed for other bacterial strains and/or environments, without proper validation studies.

One such programme is Pathogen Modelling Programme (PMP version 7.0). This programme has been developed and produced at the USDA-ARS Eastern Regional Research Center (ERRC) in Wyndmoor, Pennsylvania. The PMP is a package of models that can be used to predict the growth and inactivation of foodborne bacteria, primarily pathogens, under various environmental conditions. These predictions are specific to certain bacterial strains and specific environments (e.g., culture media, food, etc.) that were used to generate the models.

Similarly, Combined Database for Predictive Microbiology; ComBase is a database of microbial responses to food environments, supplied with browser and other supporting programs. The Com Base is jointly run by the Institute of Food Research, UK, and the USDA Eastern Regional Research Center; funded by the Food Standards Agency, UK and the USDA Agriculture Research Service. Its internet-based version is freely available via http://wyndmoor.arserrc.gov/combase. In this case, the classical predictive microbiology is based on the assumption that the rate of growth/death of a given micro-organism in the exponential phase is characteristic of its environment. The maximum rate is the maximum slope of the “log (cell-conc.) versus time” curve, in a given environment. The most important environment parameters considered are the temperature, the pH and the water activity (a quantification of water available to the cells). Other factors such as the concentrations of additives, preservatives, etc. may also influence the growth rate.

Recently, a software; Seafood Spoilage Predictor (SSP) has been developed to predict shelf life of seafood at constant and under fluctuating temperature storage conditions. This software can read data from different types of loggers and in this way evaluate the effect of fluctuating temperatures on shelf life of seafood. SSP contains relative rates of spoilage (RRS) models and microbial spoilage (MS) models. Models included in the software should only be used in products stored within the range of conditions where they have been successfully validated. A markedly expanded version of the SSP software is now available at www.dfu.min.dk/micro/sssp/.

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Quality Movement of My Time: An Outline of TQM in GCMMF

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The expression TQM (standing for Total Quality Management) came to be used in the eighties. For the dairy industry it gained entrance in 1990’s, when the winds of liberalization and economic reforms started blowing in India. However, the seeds of quality movement, it is recognized, were sown in Japan in 1950 when Dr. W.E. Deming whose name came to be recognized as synonym for quality, traveled to Japan.

Dr. Deming, an American engineer/statistician traveled to Japan in 1950 and spent 6 months conducting workshops for some 15,000 engineers. He told them that what was needed for them was to design and manufacture goods which were needed by the customer. His underscoring the customer needs marked the beginning of a quality campaign, which spread like wildfire in Japan and in the US upon his return to the US.

The compulsion for introducing TQM package for improving quality and productivity came also from the competition it spawned when customer’s needs and expectations came to be addressed and fulfilled.

The Word ‘Total’ is Used for 2 Reasons

It envelops the entire journey of goods and services offered to the consumer beginning with product manufacture and through transportation, warehousing, distribution and sale, plus redressal of customer complaints that arise for lack of quality.

It involves everyone in the organization who comes into contact directly or indirectly with the product or service not just the laboratory people, women or men, in white coats. The contribution and obligation of each department is understood by introducing the concept of INTERNAL customers which in an assembly line type of operation, (such as the manufacture of an automobile) means the next person down the line who receives the product and acts upon it, i.e. who uses the output of one worker as his input. The term delighting the customer also applies to the internal customer who can expect a perfect part.

Beside Deming other scientists and workers in the area of improving quality are: Juran: He postulated that when you look after the process, the product will look after itself. Taguchi: He stressed upon the need for a robust design for the product as also the total social cost to the society incurred on account of unacceptable quality. Deming, of course, stridently promoted improvement of the processes continuously and for ever. The processes consisting of standard operating procedures (SOPs) had to be honed so that performance by the workforce appeared to be effortless.

Some TQM Related Terms and Deliverables

Kaizen (Kai – change, zen – for the better)

So the expression has come to mean Continuous Improvement. It means small improvements carried out by the worker in his or her area of work. Kaizen done by the workforce shows involvement in work on hand. It also releases their creativity. Each Kaizen carried out by a worker is recorded and shows what the process was before and after. Group Kaizens carried out by workers in a functional area or involving cross functional groups, also promote team work so crucial to TQM implementation. Since 1994, the GCMMF has carried out some 2,50,000 Kaizens by about 800 of its employees taking the average to 2 – 3 Kaizens/person per month.
(KPP), which is about the same as what is obtained in Japan. Small gifts of the value of Rs. 5/- to Rs. 15/- may be given per Kaizen to encourage and stimulate their Kaizen inclination. Just think where an organization would be with 2,50,000 improvements carried out by its work force to smoothen their processes and routines! The accent is on reducing waste and simplifying the processes in a studied manner, not through short cuts or at the cost of affecting something else. This is one activity, which nearly all dairies are continuing. A key figure is % INVolVEMENT of the department i.e. number of Kaizens done in the department divided by its work force.

Small Group Activities are powerful tools used to tackle collectively and systematically some complex pain areas. The Japanese call such groups as Quality Circles – the difference being that in the case of Quality Circles the department professionals themselves sit down after work and tackle the problem.

In SGAs the work is carried out by a cross functional team in or out of office hours over a period of some 3 – 4 months. Over 225 SGAs have been completed by GCMMF staff. Some notable ones are (1) Reducing stock-outs of a product at the depots (2) Decreasing the second leg (upcountry) transportation time (3) Increasing the ROI (Return on Investment) of the stockists (4) Keeping only enough money at the depot as is required i.e. ‘Just-in-Time’ Finance (5) Rationalising Transport vehicle size in respect of optimal product volume, etc. The dairies have taken up Fat/SNF losses as an important SGA. Some more varied topics are - reducing the cost of milk procurement, early arrival of milk at the dairy, reducing the incidence of motor burning, reducing milk pouch leakage, etc.

**Housekeeping Includes**

**Cleanliness and Orderliness**

On a daily basis and not as a stand alone activity performed before Diwali or before the ISO 9000 inspector's visit. It involves 5S principles viz., (a) Segregation (b) Arrangement (c) Cleanliness (d) Maintenance of Standards and (e) Discipline. The Japanese have written a book on each step!

There are 5 corrective action levels in HK exercise viz., (i) Level-1: No unwanted material on horizontal surfaces, notably the floor (ii) Level – 2: No unwanted material leaning against or placed along vertical surfaces such as walls and pillars (iii) Level – 3: When walkways, corridors are clean and the factory/office is clean (iv) Level – 4: When insides of drawers, cabinets and cupboards are orderly, neat and clean, labeled, numbered and organized (v) Level – 5: Entire workplace is spanking clean and the source of dirt or extraneous matter is absent. (Notice the practice of using odd numbers by the Japanese!).

**Retrieval of Material, Information**

A well-organized office/factory should permit fastest retrievability of data, information or material – in a matter of a few minutes, if not seconds.

In GCMMF, HK has also been extended to the depot godowns and wholesale Dealers’ (WDS) storage areas. The scores (out of 100) are meticulously maintained and circulated. Shields or trophies are given to the depots showing excellent upkeep and fast retrieval of information.

Another feature of HK is RED TAG DAY – which is once a year exercise to conduct thorough house cleaning, remove the unwanted material and organize the needed material.
**Hoshin Kanri**

Is once or twice a year exercise where the company’s thrust areas are identified, shared and a blueprint for everyone’s responsibility charted out (much like the detailed arrangements of your daughter’s wedding). The document contains individuals’ goals in line with company’s objectives. The exercise is a massive, intense one-week activity involving 150 or so company employees and associates such as production, distribution, sales, etc. Hoshin Kanri means a methodology for strategic direction setting. It is a systems approach to management of change of critical areas.

**Statistical Quality Control (SQC), Shewhart 3 Sigma Control Charts And Six Sigma Principles**

Dr. W. Shewhart, another professional at about the time (slightly ahead) of Dr. Deming postulated the concept of 3 sigma control charts to monitor the health of processes on a daily basis. He indicated that when a process was healthy and under statistical control, nearly all (99.7%) of samples under test for a particular quality characteristic fell within 3 standard deviations (represented by the Greek alphabet sigma) of the long term average. These 3 sigma limits were called Upper Control Limit UCL and Lower Control Limit, LCL. Test results falling outside these limits were considered as belonging to special or fleeting reasons while variation noted day to day which fell within 3 sigma upper and 3 sigma lower than average line were assigned “common” causes requiring no change in the process setting as against special causes which required immediate attention to bring back the process under control once again.

Dr. Deming popularized the use of simple 3 sigma control charts by each worker to monitor the behaviour of his process. In a factory such as Toyota car manufacturing facility, scores and scores of control charts would be displayed by the operators engaged in the production process.

**Six Sigma**

In about 1985 Motorola Company of USA devised and assigned the term 6 sigma level of accuracy to their processes when nearly defect free items or product and service were obtained (In practice no more than 3 defective items/million opportunities).

The key business process in a dairy is sealing (such as in ship building, it is welding). Even a 0.1% defect level for GCMMF’s 250 MT daily powder will generate 500 complaints which is far too many than GCMMF can afford. Hence the search for 6 sigma level of accuracy. The concept looks and sounds alluring but to achieve it all the processes all across the organization have to be perfect. It is nothing short of tapasya. Through ingenuity and use of colour and numerical combinations, Mumbai dabbawalas (tiffin box carriers) have been awarded 6 $\sigma$ by Forbes Global. Some similar breakthrough is required to achieve level of accuracy of sealing and other packaging processes for the dairy industry to earn 6 $\sigma$. One cannot just wish or order or legislate 6 $\sigma$. 

Concept of Quality Old and New

<table>
<thead>
<tr>
<th>Old</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Specification driven (PFA, BIS, Agmark, etc.)</td>
<td>Based exclusively on customer requirement, e.g. milk delivered at your doorstep</td>
</tr>
<tr>
<td>2 Inspection based (checks and rechecks in the laboratory)</td>
<td>Quality built in and supported by visual controls, Poka-Yo ke, SQC charts and other tools so that the product goes through like a “green channel”.</td>
</tr>
<tr>
<td>3 Responsibility of QC/QA or Laboratory staff</td>
<td>Every one in the organization has to have ownership</td>
</tr>
<tr>
<td>4 Focus on Product</td>
<td>Focus on the process</td>
</tr>
<tr>
<td>5 Slow to change in respect of quality characteristics</td>
<td>Improves with ever increasing requirement of the customer, e.g. miscibility of milk powder in cold and hot water.</td>
</tr>
</tbody>
</table>

Amul Quality Circles

On every third Saturday of the month Amul Quality Circle meetings are held between 3 to 6 p.m. all across the country. The wholesale dealers take turns in hosting the meeting. The Federation Field Sales Representative typically facilitates the meeting. The discussion includes all issues of product distribution and sales. The WDs compare notes of their day to day problems including product information, retail penetration, market complaints, product complaint settlements, new products intended to be introduced, etc. All WDs travel to the meeting at their own expense and in a spirit of friendship. The basic agenda enlisting recent activities for the meeting is drawn up at the Federation HO through Distribution Department and circulated to all depots for the conduct of AQC meetings. To this, variable agenda items pertaining to typical local concerns are added by each A.Q.C. These Quality Circles have now been a permanent feature since their introduction in 1997. These also give an opportunity to the Wholesale Dealers to meet each other as well as the GCMMF employees on a monthly basis and voice their problems and concerns.

Friday Departmental Meetings

After introduction of TQM in GCMMF, Friday Departmental meetings began in 1995. Since then such meetings are conducted across the organisation every week on Friday from 10.00 am to 11.00 am. These provide opportunities for the employees to contribute to the quality objectives of the organisation. The agenda is fixed, and all the TQM initiatives are addressed in these departmental meetings. The standard agenda includes, review of quality initiatives like Kaizen, Housekeeping, progress on SGA, etc. followed by information sharing and resolving of intra-departmental pain areas. This forum has been working effectively in improving communication with employees. ‘Process check’ at the end of each meeting brings out effectiveness of the meeting as perceived by the customers i.e. the employees themselves.

Nuggets From Deming

1) When quality goes up, the cost comes down and the productivity increases.
2) What cannot be measured cannot be controlled (quotation adapted).
3) One supplier or as few suppliers as are practical for packaging or other materials is desirable. He can work with you from the beginning, get a big order and make investments for improvement of his operation.
4) Just-in-time concept should be aimed at for supplies, transportation and other process needs. This will reduce inventory level to a healthy low.

5) Make the organization a LEARNING organization by instituting training from within the company and from outside. Perpetual training is needed to keep abreast of activities for increased quality and productivity.

Many of our dairies have started 3 sigma control charts for utilities viz. water use/unit milk handled, Furnace Oil, kWh for refrigeration etc. Dock level milk pouch leakage is measured regularly. Record is also being kept for consumables like lye, acid, teepol used/unit milk handled.

1. Quality should not depend upon demand and supply or on other similar reasons. Quality when it is convenient is a bad credo.

2. Total employee involvement and employees’ total involvement is necessary to promote teamwork.

3. My work is not done until my department’s work is done.

4. Think win-win.

5. What you see as waste is only a tip of the iceberg. There are many layers of waste, which can be peeled off to get at the core work.

6. In all spheres keep the customer at the center. You can never go wrong.

7. Structured problem solving should be taught to everybody involved in SGA work. Others should practice Plan-do-check-act cycles (PDCA Cycles).

In closing, it can be said that 100% inspection is no solution to ensuring quality. So, what can improve quality? It has to be built in the process. How do you achieve that? By having “Operator Has Ownership” as the work credo for every one.
Quality and Safety Issues in Value Addition

DR. S. K. BHALLA
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Introduction

At the time of independence, India started with a milk production of mere 17 million tonnes per annum and in the year 1998-99 it has reached a record 78 million tonnes replacing United States as the world’s largest milk producing country. With the present growth rate of 5.5 % India is expecting to produce 250 million tonnes by the first quarter of this century, which is more than one third of the projected global production. The present per capita availability of milk is about 232 gram per day, which is the result of organized efforts in dairy development undertaken by the country since 1970, the year Operation Flood project was launched by National Dairy Development Board. Today, over 275 liquid milk plants and 83 milk product factories in the cooperative, public and private sector handles about 12-15 % of the total milk produced.

The dairy sector has been experiencing a great surge following the opening up of the international trade in the fast changing economic scenario of the country. While the opportunities are many, they have also posed several challenges to the Indian dairy industry. Having done exceedingly well on the production front, time has come for the Indian dairymen to record similar outstanding performance on the quality front.

What Is Quality?

According to the International Organization of Standardization (ISO), the definition of quality is : the totality of features and characteristics of a product and service that bears on its ability to satisfy stated or implied needs. The quality encompasses safety, hygiene, reliability, wholesomeness, and acceptance to consumers. Quality conveys different meaning to different people.

Quality is not an option, it’s an obligation. Milk and milk products’ quality is a most important factor in present day dairying. Quality is an outcome of intelligent efforts and strong will to produce a superior food article of internationally accepted standard. The long term prosperity of dairying depends on the quality commitment of all individuals involved in taking milk from the cow and delivering it to the table.

Future Challenges

Increased competition as a result of globalization, zeal for international marketing, and increased consumer awareness have instigated the dairy industry to device foolproof methods to ensure micro-biological and phytosanitary quality of milk products. Having made such dramatic achievements in the quantum of milk production over the last four decades, making us the largest milk producer in the world, the time has come to focus on achieving similar feat on the quality front. To achieve our goals we need to upgrade our standards of quality and technology, refine the existing technologies, improve the management practices and adopt modern analytical tools.

International Dairy Standards under WTO Regime

With the establishment of World Trade Organization (WTO) on 1st January 1995, The process of globalization due to diminishing of protectionist measures has been set in motion. Consequent to these developments, it appears that the world would, in due course, become
a single market place with all types of product crossing international borders with ease never seen before. These developments have magnified the importance of the international standards, which would provide the legal framework for the increased trade in dairy products. To minimize the possibility of disguised restrictions on international trade, two binding agreements relevant to food regulations were signed under the WTO regime. These are - Agreement on Application on Sanitary and Phytosanitary Measures (SPS Agreement) and the Agreement on Technical Barriers to Trade (TBT Agreement). The SPS Agreement encourages Governments to establish national SPS measures consistent with International standards, guidelines and recommendations developed by international organizations. For food safety this organization is joint FAO/WHO Codex Alimentarius Commission (CAC). The WTO has recognized only Codex standards as the basis for international food trade. It is likely to be a survival of the fittest as far as adoption of international standards is concerned. Therefore, it is imperative that the Indian Dairy industry begins to orient itself and participates more actively in the future work of the elaboration of international rules and regulations in order to protect India’s interest.

Quality Management Systems

It must be recognized that much of the success achieved in Indian dairying and our fortunate competitive position in the world is the result of what economists call factor advantages. India has soils, climates, local agricultural economics, transportation infrastructures, educational institutions and research capabilities that have created the foundation of modern dairy industry. But there is no room for complacency. If India has to export milk and milk products as a substantial part of its future growth, it must improve and innovate to sustain its competitive advantages through total quality management systems.

Quality Management Systems are a new genre of modern management concepts to improve effectiveness, flexibility and competitiveness in an organization as a whole. It can help the dairy sector in producing cost effective quality milk products. There are many systems available, which the dairy industry has started adopting to win customer confidence and thereby to gain the cutting edge of the competition. Some of them are listed below:

1. **ISO 22000: Food Safety Management System (HACCP)**: This is a science-based food safety management system which systematically identifies specific hazards - microbiological, chemical and physical, and provides measures for their control to ensure safety of food. It is a tool to assess hazards and establish control system that focuses on prevention rather than relying on end product testing. A successful and effective implementation of the HACCP system requires the use of risk-based decision making in identifying significant hazards at different points in the food chain and establishing critical limits at specified critical points for monitoring and ensuring food safety.

2. **ISO 9000**: It provides a mechanism for –
   - Determining and fulfilling customer needs
   - Consistency in quality of products and services
   - Preventing errors
   - Correcting the errors
   - Improving the process
   - Integrating all related functions of quality
   - Brings clarity and transparency in duties and responsibilities
   - Improves traceability
   - Improving Human Resource/Skill upgradadition
3. **Total Quality Management (TQM)**: TQM can be defined as an integrated organizational approach in delighting customers (both internal and external) by meeting their expectations on a continuous basis through everyone involved with the organization working on continuous improvement in all spheres namely products, services and processes along with proper problem solving methodology. If implemented properly, TQM can bring the following benefits to the organization.

- **For Customers** -
  - Value for money
  - Greater customer care
  - No complaints
  - Better availability
  All these will result in better customer loyalty.

- **For Company** -
  - Continuous improvement in quality
  - Reduction in cost
  - Increase in productivity
  - People are better motivated
  - Defects are reduced
  - Problems are solved faster
  All the above will result in increased ROI, net profits and cash flow.

- **For Employees** -
  - Empowerment
  - More training skill
  - Appreciation and recognition
  - More respect

Some of the main activities available under TQM are:

- House keeping
- Kaizen
- Small Group Activity (SGA)
- Quality Circles (QCs)
- Policy deployment (Hoshin Kanri)
- Just in Time (JIT)

4. **Environmental Management System (IS : 14000)**: Environment is defined as surroundings in which an organization operates, including air, water, land, natural resources, flora, fauna, humans and their interrelation. The environmental management system brings the following:

- Structured, systematic, documented and voluntary approach
- Pro-active identification and control of environmental aspects
- Ensures compliance with legislation
- Continual improvement in environmental performance
- Sustainable dialogue with interested parties
- Institutionalize preventive strategies
**Value Addition with Safety**

The term “safe food” represents different ideals to different audiences. Consumers, special interest groups, regulators, industry, and academia will have their unique descriptions based on their perspectives. Much of the information the general public receives about food safety comes through the media. For this reason, media perspectives on the safety of the food supply can influence those of the general public.

Consumers are the end users and thus are at the last link of the food supply chain from production, through processing and distribution, to retail and food service businesses. Consumers are multidimensional and multifaceted. Populations differ in age, life experiences, health knowledge, culture, sex, political views, nutritional needs, purchasing power, media inputs, family status, occupation, and education. The effect of the interrelationships of these factors on an individual’s description of “safe food” has not been established.

Safe food means food prepared on clean and sanitized surfaces with utensils and dishes that also are cleaned and sanitized. These consumers mention the importance of hand washing by those involved in food preparation and the importance of not reusing cloths or sponges that become soiled. Common sense is a guiding principle for the educated, informed consumer.

Other consumers want safe food that retains vitamins and minerals but does not have harmful pesticides. They describe safe food as food that is within its shelf life and has been stored and distributed under proper temperature control. Some consumers know the word “contamination” and will define safe food as food that is not contaminated.

**Clean Milk Production**

Production of good quality raw milk is of utmost importance, as premium quality products can not be made from bad quality raw milk. To give an indication of the challenge before us, it is not unusual for raw milk in our country to have approximately 8 - 10 million bacteria per ml when milk arrives at the reception dock of dairy, as against 0.1 million - the world standard. Hence action is required to be initiated at the point of milk production itself so that progressive quality remains under monitoring and control. It is the time to recognize the need of an implementation of schemes for upgrading hygienic quality. The following factors in the production of good quality milk are worth considering:

- Safe Farm Practices
- Keeping the milch animals healthy
- Hygienic status of animal born and milking byre
- Personal hygiene of the milker and milking practices followed
- Cleanliness and sanitation of milking and subsequent milk handling utensils
- Prompt cooling after milking
- Incentive based pricing

However the most important aspect is a need for creating social awareness about milk quality. This would work as an incentive to dairymen as demand for better quality milk would automatically ensure better gains and a place in the global market.

**Buffalo Milk Utilization**

Buffaloes are the second largest milk producers of the world. India is unique in buffalo milk production as it alone accounts for two third of world production. The differences in quantitative and qualitative aspects of various milk constituents between the cow and buffalo milk in turn leads to the differences in various physico-chemical and functional properties of
the two milks and the products made therefore. Higher total solids content, denser white appearance, higher viscosity etc. are some of the useful attributes, which make buffalo milk more suitable compared to that of cow for manufacturing certain varieties of dairy products, e.g.

• Mozzarella cheese - due to better stretchability, more piquant and aromatic flavour.
• Domiati cheese - due to ease of manufacture, superior colour and higher yields.
• Tea or coffee whitener - due to superior whitening properties.
• Lactose and its derivatives - due to higher yields.
• Edible caseins and caseinates - due to ease of manufacture and higher yields.
• Khoa - due to smooth and mellowy texture.
• Dahi, yoghurt and shririkhand - due to better body & texture and higher yields.
• Icecream and frozen desserts - due to superior viscosity.
• Cream, cooking butter, ghee and butter oil - due to higher yield, better texture, and keeping quality.

In some countries where buffaloes are not prevalent, buffalo milk is perceived as a product coming from black, hairy animals with inferior sensory and health attributes. However, keeping the inherent superiority of buffalo milk in mind a fresh look is the need of the hour on the quality front of buffalo milk. In such case the global standard has to be kept in mind (which is at present heavily lopsided in favour of cow milk) and review the quality to conform to them.

**Environment and Animal Health**

Presence of aflatoxins, heavy metals, antibiotic residues, and pesticide residues are increasingly becoming areas of major food safety concern. SPS measures permit members to adopt, if considered necessary, a higher level of protection based on risk assessment. Codex Alimentarius Commission has already laid down very stringent Maximum Residue Levels (MRLs) of these contaminants for some of the milk and milk products and working on some others. India may suffer a major setback in the international dairy trade due to these stringent provisions if immediate measures are not taken to control levels of these contaminants.

- Government to initiate control measure on use of pesticides, control of unwanted production of banned drugs. Control of environmental hazards like smoke, fuel, condition of transportation systems.
- Preventive measure on groundwater pollution.
- Control on process industries.

**New Products for Indian Dairy Industry**

Gone are the days when conversion of surplus milk to ghee and butter formed the cornerstone of Indian dairy industry. In the era of globalization and rapid progress of information technology communication revolution there has been a phenomenal increase in demand of new products with improved qualities. The focal point has been shifted to consumer convenience, improved shelf life and added nutritive value and to provide consumers a ready-to-use milk based product at reasonable cost.

The market for the traditional Indian dairy products far exceeds that of conventional dairy products like butter, milk powder, cheese etc. In the past, the Indian dairy industry has
shown very little interest to traditional dairy products, as a result of it manufacturing of these products till remains in the hands of small scale sweet meat makers. During the manufacturing of indigenous products on cottage scale almost no attention is paid to sanitation and quality aspects. The invariable occurrence of a large number of micro-organisms and adulterants not only reduce the nutritive value and shelf life, but also a source of potential health hazard to the consumers. Therefore, innovations, which will enable the organized sector to manufacture indigenous product hygienically, employing Good Manufacturing Practices on an industrial scale can have a far reaching impact on the dairy industry. A great scope exists for Indian dairy industry to exploit the market of the indigenous dairy products by adopting mass production technologies.

VALUE ADDITION ?

Value addition can be achieved by creating genuine benefits in technical, functional and emotional use of products by consumer. The details of parameters of value addition are given below:

<table>
<thead>
<tr>
<th>1 Characterization of Food Safety and Risks</th>
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<tbody>
<tr>
<td>1. Definition of food safety</td>
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<tr>
<td>2. Characterization of food hazards</td>
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<tr>
<td>3. Risk analysis frameworks for chemical and microbial hazards</td>
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<td>4. Dose-response modeling for microbial risk</td>
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<td>5. Exposure assessment of microbial food hazards</td>
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<td>6. Exposure and dose-response modeling for food chemical risk assessment</td>
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<td>7. Economic consequences of food borne hazards</td>
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<th>2 Food Hazards: Biological</th>
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<tr>
<td>1. Prevalence of food borne pathogens</td>
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<tr>
<td>2. Physiology and survival of food borne pathogens in various food systems</td>
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<tr>
<td>3. Characteristics of biological hazards in foods</td>
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<tr>
<td>4. Contemporary monitoring methods</td>
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<tr>
<th>3 Food Hazards; Chemical and Physical</th>
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<tbody>
<tr>
<td>1. Hazards from natural origins</td>
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<td>2. Chemical and physical hazards produced during food processing, storage, and preparation</td>
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<tr>
<td>3. Hazards associated with nutrient fortification</td>
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<tr>
<td>4. Monitoring chemical hazards: regulatory information</td>
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<tr>
<td>5. Hazards resulting from environmental, industrial, and agricultural contaminants</td>
</tr>
<tr>
<td>6. SYSTEMS FOR FOOD SAFETY SURVEILLANCE AND RISK PREVENTION</td>
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<tr>
<td>7. Implementation of fsis regulatory programs for pathogen reduction</td>
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<tr>
<td>8. Advances in food sanitation: use of intervention strategies</td>
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<tr>
<td>9. Use of surveillance networks</td>
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<tr>
<td>10. Hazard analysis critical control point (HACCP)</td>
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<tr>
<th>4 Food Safety Operations in Food Processing, Handling, and Distribution</th>
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<tbody>
<tr>
<td>1. Food plant sanitation</td>
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<tr>
<td>2. Food safety control systems in food processing</td>
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<tr>
<td>3. Food safety and innovative food packaging</td>
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<tr>
<td>4. Safe handling of fresh-cut produce and salads</td>
</tr>
<tr>
<td>5. Good manufacturing practices: prerequisites</td>
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</tbody>
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<thead>
<tr>
<th>5 Food Safety in Retail, Foods</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Commercial food service establishments: the principles of modern food hygiene</td>
</tr>
<tr>
<td>2. Institutional food service operations</td>
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<tr>
<td>3. Food service at temporary events and casual public gatherings</td>
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<tr>
<th>6 Diet, Health, and Food Safety</th>
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<tbody>
<tr>
<td>1. Medical foods</td>
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<td>2. Food fortification</td>
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<tr>
<td>3. Sports nutrition</td>
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<td>4. Dietary supplements</td>
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<tr>
<td>5. Functional foods and nutraceuticals</td>
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CONCLUSIONS

Commitments of the agriculture sector under the world trade organization (WTO) should be viewed more as an opportunity than a threat. This opportunity could be capitalized through value addition, improvement in quality of products, setting up of ISO standards, R & D establishment and certification facilities. World over, agriculture is increasingly moving towards a system of total quality control which would encompass not only the grammar of production but also the system of farming. The changed scenario in the international trade would bring food safety issues and non-tariff barriers sharply into focus. WTO, which stresses on customer safety, product standards, sanitary and phyto sanitary requirements would be of much importance in the global trade.

Food safety is ensured by the shared responsibility of everybody involved with food from the professional to the consumer. All along the food chain, various procedures and control mechanisms are implemented to assure that the food which reaches the consumer table is fit for consumption, that the risks of contamination are minimized, so that the population as a whole is healthier from the benefits of safe quality food.
India is the world’s largest producer of milk with an annual output of 84 million tons. With the increase in milk production, product exports have also increased. Nearly 50% of the country's output of 220 million liters of milk is being converted into products as khoya, sweets, cheese, ghee, milk powder, baby foods, malted foods and whey proteins.

In casein and lactose industry, skim milk is the major product and ghee is the by-product. In skim milk, casein and lactose are the prime product and rest are secondary ingredients. The ingredients of skim milk have high nutritional value. Casein is the major protein in milk and constitutes about 80% of total protein content of which the rest, some 20% are the whey or serum proteins. Commercial casein is made from skim milk by one of two general methods – precipitation by acid to make acid casein or coagulation with rennet to make rennet casein.

**CASEIN**

There are two types of caseins available in the market: edible casein and industrial casein. The above two types of casein can be either acid casein or rennet casein. Edible casein is a long established dairy product finding its use as an ingredient in many dairy and food products.

The general development in technologies and the new uses in foods have ever increased the production and demand of this product. Its manufacture differs from industrial casein (i.e. non edible) that is produced under sanitary condition. Further, during its manufacture, food grade chemicals are to be used and it is sufficiently heat treated to make its safe human consumption. Appropriate national and international standards for this product call for rigorous control during its manufacture. The intensive investigation in manufacturing technologies over the years and the introduction of efficient plant designs has immensely improved the technology of edible casein.

**Manufacturing Process**

**Influence of Raw Material**

In order to produce high quality casein, the raw material, skimmed milk, must be of good quality. If bacteria have had time to act on the protein in the milk as a result of a change in acidity, this will affect the colour and consistency of the casein, which will acquire a grayish colour and a smoother consistency. Excessive heating of the milk before precipitation will not only cause assorted interactions among the lactose, casein and whey protein constituents but also give the casein a yellow or at worst a brownish colour.

In order to produce casein of good bacteriological quality, without high heat treatment of the skim milk, the pasteurization plant may also contain a micro-filtration (MF) plant. To satisfy the high demands on the quality of casein intended for use in the food industry, not only must the production line be carefully planned right from the reception of the milk, but the treatment and handling of the raw material prior to this stage must also be carefully controlled.
Rennet Casein

Skimmilk, normally pasteurized at 72°C for 15-20 seconds, is used for the production of rennet casein as well as other types of casein; Small amounts of fat are detrimental to the quality. It is therefore important that the milk has been separated efficiently.

Rennet Casein Production

Renneting takes place with the help of the enzyme chymosine in the rennet. The milk is heated for a short period of time and then cooled to about 30°C. Then the rennet is added. A gel forms after 15-20 minutes. It is cut and the coagulum is stirred while being heated to about 60°C. The high temperature is needed to deactivate the enzyme. Cooking time approx. 30 minutes.

Continuous Washing

Rennet casein was originally produced in batches in special casein tanks, but nowadays-continuous processes are also used. In a continuous plant, drainage of whey takes place before the casein passes through two or three washing tanks with agitators. Dewheying is normally done in a decanter centrifuge to reduce consumption of wash water.

The casein is dewatered between washing stages, either on inclined static strainers or in decanters. After leaving the washing stages, the water / casein mixture goes through another decanter to discharge as much water as possible before final drying.

In large-scale production, coagulation of the casein is still done batch wise with a calculated number of casein vats emptied in sequence to feed the continuous dewheying and washing plant. Washing takes place in countercurrent, which is much more economical of water than concurrent washing.

Acid Casein

The milk is acidified to the isoelectric point of casein, which is usually reckoned to be pH 4.6, but it is shifted by the presence of neutral salts in solution and may be anywhere within a range extending from pH 4.0 to pH 4.8. The isoelectric point is the stage where the hydronium ion concentration neutralizes the negatively charged casein micelles, resulting in precipitation (coagulation) of the casein complex. Such acidification can be carried out biologically or by addition of a mineral acid, e.g. hydrochloric acid (HCl) or sulphuric acid (H₂SO₄).

Mineral Acidification – Acid Casein

The milk is heated to the required temperature, approx. 32°C. Mineral acid is then added to bring the pH of the milk to 4.3 – 4.6. Following the pH check, the milk is heated to 40-45°C in a plate heat exchanger and held for about two minutes, when smooth aggregates of casein are formed. To remove as much as possible of the whey before washing starts, the whey / casein mixture is passed through a decanter. In this way, less water is needed for washing.

Before leaving the plant whey and wash water can be separated and the casein sludge is collected in a tank. When mixed with a lye solution, the casein dissolves and is then remixed with the Skimmilk intended for casein production.

After dewatering, the acid casein is ground and packed in sacks.
Fig. 1: Flow diagram for manufacturing process of Acid casein

- Raw Milk
- Quality checking
- Weighment
- Chilling
- Silo storage
- Preheating
- Separation
- Skim milk
- Pasteurization
- Storage
- Skim milk
- Acid Coagulation
- Decantation
- Whey
- Casein washing
- Decantation
- Casein washing
- Decantation
- Drying
- Milling
- Casein Packing

Annex – A: Manufacturing equipments of Acid casein
**Utilization of Whey**

Whey is the largest byproduct of the dairy industry. It is obtained during the manufacture of casein, cheese, paneer, chhana and shrikhand. In whey lactose is the major product and whey proteins, water-soluble vitamins and minerals are secondary product. In India, milk products like paneer, shrikhand and chhana are very popular and are in great market demand. With the increase in their production levels, there is a corresponding increase in the whey as a by-product. In India about 3 million tons of whey is produced from indigenous milk products and about 30 million tons of whey from casein and cheese production is annually. The worldwide production of whey appears to be in the order of about 90 billion liters (1996). On an average, the manufacture of 1 ton of cheese or casein results in the production of 8 or 25 tons of liquid whey, respectively. To overcome this pollution problem ultra-filtration of whey is carried out to concentrate the native whey proteins in order to obtain whey protein concentrate with varying protein contents i.e. 35 to 90% protein on DMB. Whey is the liquid remaining after recovery of curds. The whey contains more than half the solid present in the original whole milk, including 20% of the protein (whey protein) & most lactose, minerals, and water-soluble vitamins.

**Fig. 2: Flow diagram for manufacturing process of WPC**

```
Whey
    ↓
Clarifier
    ↓
Pasteurization
    ↓
Storage
    ↓
UF Feed
    ↓
WPC
    ↓
Concentrate
    ↓
Chilling
    ↓
Storage
    ↓
Heating
    ↓
Spray Drying
```

**Annex-B: Manufacturing equipments of WPC**
Utilization of Permeate

Permeate is a solution which penetrates the membrane during UF processing of milk or whey and which consists mainly of lactose in the same concentration as in the water phase of the original liquid. Besides lactose, minerals and vitamins are fractionated between the retentate and permeate; the permeate will contain about 80% of the original lactose, whilst the other components will pass into permeate in various proportions. It has a BOD of 30,000 – 45,000 mg O₂/liter and can’t be directly disposed as wastewater into sewage.

The composition of permeates from different sources

<table>
<thead>
<tr>
<th>Component</th>
<th>Content (%) of permeate from Milk</th>
<th>Content (%) of permeate from Sweet whey</th>
<th>Content (%) of permeate from Acid whey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total solids</td>
<td>5.80</td>
<td>5.80</td>
<td>5.80</td>
</tr>
<tr>
<td>Lactose</td>
<td>4.90</td>
<td>4.90</td>
<td>4.10</td>
</tr>
<tr>
<td>Ash</td>
<td>0.45</td>
<td>0.50</td>
<td>0.70</td>
</tr>
<tr>
<td>Crude protein (NPN) (N&lt;sub&gt;μ&lt;/sub&gt;6.38)</td>
<td>0.25</td>
<td>0.30</td>
<td>0.40</td>
</tr>
<tr>
<td>Lactic acid</td>
<td>—</td>
<td>0.15</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Permeate is evaporated, crystallized, washed, centrifuged and dried for ±-lactose monohydrate. On a dry matter basis, permeate contains roughly 85% lactose, 11% minerals and 3.5% NPN and permeate originated from acid whey contains about 3% lactic acid as dried product.

Fig.3: Flow diagram for manufacturing process of Lactose

UF Feed
  ↓
WPC
  ↓
Permeate
  ↓
Evaporation
  ↓
Crystallization
  ↓
Decantation
  ↓
Crystal mass
  ↓
Crystallization
  ↓
Decantation
  ↓
Lactose Mass
  ↓
Lactose Drying
  ↓
Milling & Packing
  ↓
Mother Liquor
  ↓
Mother Liquor

Annex – C: Manufacturing equipments of Lactose
Utilisation of Mother Liquor

The remaining liquid from the centrifugation after lactose crystallization, which is called mother liquor, contains roughly 50% lactose (anhydrous), 35% minerals and about 15% NPN on dry matter basis; it can be utilized for minerals precipitation i.e. Dicalcium phosphate.

Content of minerals, trace elements and vitamins present in mother liquor obtained from permeate of different sources.

<table>
<thead>
<tr>
<th>Component</th>
<th>Milk</th>
<th>Sweet whey</th>
<th>Acid whey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minerals (mg/100gm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ca</td>
<td>28</td>
<td>30</td>
<td>95</td>
</tr>
<tr>
<td>P</td>
<td>33</td>
<td>40</td>
<td>55</td>
</tr>
<tr>
<td>Mg</td>
<td>8</td>
<td>7</td>
<td>8.0</td>
</tr>
<tr>
<td>K</td>
<td>140</td>
<td>150</td>
<td>140</td>
</tr>
<tr>
<td>Na</td>
<td>40</td>
<td>65</td>
<td>45</td>
</tr>
<tr>
<td>Cl</td>
<td>—</td>
<td>120</td>
<td>100</td>
</tr>
<tr>
<td>Trace elements (mg/100gm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zn</td>
<td>6</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Fe</td>
<td>5</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Cu</td>
<td>—</td>
<td>0.50</td>
<td>0.70</td>
</tr>
<tr>
<td>Mn</td>
<td>0.20</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>Vitamins (mg/100gm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B₁</td>
<td>27</td>
<td>28</td>
<td>90</td>
</tr>
<tr>
<td>B₂</td>
<td>110</td>
<td>90</td>
<td>90</td>
</tr>
</tbody>
</table>

Utilisation of NPN

NPN is obtained during separation of minerals from mother liquor. The composition of NPN is proteose peptones, Urea, Amino acids and NH₃. The composition of product is given in Fig.1.

Utilization of Filtrate Fraction Obtained after Mineral Separation

Chromatographic separation using a sulphonated cation exchange resin has several industrial applications. It is a fractionation method based on ion exclusion and a molecular sieve effect. In principle, it could thus allow removal of non-ionized small-molecular compounds (e.g. lactose) from large molecular (e.g. proteins) and ionized small molecules (e.g. salts).

Utilisation of Minerals Powder

The salts of milk are mainly the phosphates, citrates, chlorides, sulphates, carbonates and bicarbonates of sodium, potassium, calcium and magnesium. Approximately 20 other elements are found in milk in trace amounts, including copper, iron, silicon, zinc and iodine. The major elements are of importance in nutrition, in the preparation, processing and storage of milk products due to their marked influence on the conformation and stability of milk proteins, especially casein’s, and to a lesser extent the stability of lipids and the activity of some indigenous enzyme. After fractionation of lactose from minerals, the remaining minerals are citrates, chlorides, sulphates, carbonates & bicarbonates of sodium, potassium, etc.
Fig. 4: FLOW DIAGRAM FOR MANUFACTURING PROCESS OF DCP
Food Safety Management System Based Certification For Dairy Products

MR. H. K. MONDAL
Deputy Director
Export Inspection Agency, New Delhi

Introduction

The Export Inspection Council (EIC), as you may be aware, is the official certifying body for Exports. The organization is a statutory body set up by Govt. of India, Ministry of Commerce & Industry under the Export (Quality Control & Inspection) act 1963. In order to ensure sound development of Export trade of India through quality control and Inspection. EIC provides mandatory certification for various food items namely, Fish & fishery products, Dairy Products, Egg products, Meat & Meat products, poultry and poultry meat products and honey and while other food and non food items are being certified on voluntary basis. The certification is given against the standards of importing countries or in absence of this, international standards/ Indian National Standards. Export Certification is carried out through its field organization, Export Inspection Agency (EIAs) located at Mumbai, Kolkata, Kochi, Delhi and Chennai and 41 sub offices and is based on a system approach to include GMP/ GHP/HACCP and also tailored to meet the requirements of the importing country. EIC certification is recognized by several of Indian Trading partners while with others the dialogue is on for seeking recognition.

Though, India is the largest milk producer in the world, its exports are relatively insignificant. Major factors for low export of milk products are the quality and safety aspects. Consumer of all over the world is showing their preference for high quality of products. Beside with the establishment of WTO and further increase in global trade, due to removal of quantitative restrictions, the Governments have realized their role in protecting the health and safety of their populations by imposing stringent restrictions relating to pesticides residue, heavy metals, contaminants, microbiological parameters as well as various aspects of hygiene control.

Many importing countries such as U.S.A., E.U., insist on implementation of Food Safety Management System (FSMS) such as H.A.C.C.P /G.M.P /G.H.P rather then depending on final product inspection.

On the similar approach E.U. has issued directive no. 92/46/E.E.C. dated 16-06-1992 laying down general hygienic condition for processing, storage, packaging and transportation of milk products for approval of milk processing unit to produce wholesome and safe milk products.

Export Certification System for Dairy Products

In light of the development in the International Market, Ministry of Commerce and Industry, Govt. of India has issued order / notification wherein dairy products have been brought under compulsory quality control inspection and certification vide S.O. No. 2719 and 2720 dated 28/11/2000 under the export of milk products (Quality Control, Inspection and Monitoring) Rules 2000.

The milk product processing unit is required to meet the sanitation and hygiene and other food safety requirement as laid down in the said notification for getting approval from E.I.C. / E.I.As. for export.
**Specification for Milk Products for Export**

Specification for milk products recognized for export as per the notification shall be:-

a. National Standard of Importing Countries or Codex Standards of Codex Alemnterious Commissions.  
   Or

b. Contractual Specification agreed to between the foreign buyer and the exporter provided the same is not below the National Standard of the Importing Countries.

c. In absence of a or b above, the National Standard Specifications as notified shall apply.

**The conditions to be fulfilled in order to export Milk Products**

a) Any statutory restriction imposed by any State/Central govt. with respect to commercial / environmental /conservation measures from time to time.

b) They must have been obtained milk from dairy animals, which are apparently healthy and do not show any visible symptoms of infectious disease likely to be transferred to human through milk. Further, animals, which have been treated with Antibiotics, or other veterinary drugs, which can be transferred to milk, shall not be brought to the collection center unless the retention period of drug is over.

c) They must contain only the permissible food, additives / processing aids other than milk, which are fit for human consumption within the specified limit.

d) They must have been treated and prepared in an approved plant.

e) They must have been processed and or manufactured under hygienic conditions.

f) They must have been packed by observing:
   • Wrapping and packaging must take place under satisfactory hygiene conditions in rooms provided for that purpose.
   • Bottling, filling of containers with liquid milk products and sealing of containers and packaging must be carried out automatically.
   • Wrapping on packaging may not be reused for the products with the exception of certain types of containers, which may be reused after through cleaning and disinfecting.

g) They must have been stored at the temperature established by the manufacturers to ensure their durability. In particular, the maximum temperature of 6 C at which pasteurized milk may be kept until it leaves the establishment and during transportation. When stored under cooled conditions the storage temperatures must be registered and the cooling rate must be such that the product reaches the required temperature as quickly as possible.

h) The processor shall indicate the period during which the milk products are fit for human consumption and storage.

i) The results of the various checks and tests are recorded and kept for presentation to the competent authority for a period of two years.

j) To detect any residues of substances having a pharmacological or hormonal action and of antibiotic, pesticide, detergents and other substances should not be present in the milk, which might alter the sensory characteristic of milk products or make their consumption harmful or dangerous to human health.

k) If the milk products examined show traces residues in excess of the permitted levels fixed, they must not be allowed either for the manufacture of food stuffs or for direct human consumption.

l) Tests for residues must be carried out in accordance with National / International, recognized methods.
Procedure for Approval of a Processing Plant

The processor seeking approval of their plant submits an application in prescribed format along with relevant documents and HACCP manual including SSOP to concerned Export Inspection Agency (EIA) of their region. Any discrepancies/shortcomings observed in the application are immediately communicated to the applicant for rectification. Desk audit of HACCP manual including SSOPs are also carried out and any deficiencies observed are communicated to the applicant for rectification.

Applications complete in all respects will be forward to convener of Inter Departmental Panel (IDP), the convener will be from the concerned EIA. The members of IDP are from APEDA, NDRI, Ministry of Agriculture, Ministry of food Processing, NDDB-New Delhi, and Indian Dairy Association.

The IDP will visit the plant to adjudge the facilities available in the plant and give their specific recommendations for approval or otherwise. The minimum corium of the IDP will be three members including the convener.

The recommendation of the IDP will be placed to In charge of EIA for issuance of approval letter to the processing plant or otherwise.

Certificate of approval will be issue by the Director (Q/C & I), EIC New Delhi.

The validity of certificate of approval will be for a period of 2 years from the date of issue of the letter of approval.

Marking On the Export Packaging

It is mandatory for the approved plant to put approval number & Q-Mark on all export packages by printing/stenciling, besides the requirements as stipulated in the export contact or the requirements of the importing country.

Monitoring and Control by Processor to Produce the Safe Milk Products.

It is the primary responsibility of the processor to ensure compliance with the requirements of the notification and to ensure safety and wholesomeness of the product.

Processing plants shall exercise all controls required as per notification and maintain records thereof in respect of following broad areas.

- Hygienic requirements relating to the premises.
- Structure & layout
- Pest control (Prevention, Extermination, Use of Chemicals)
- Maintenance
- Cleaning and Sanitation
- Personal Hygiene
- Rest Room
- Water Management
- Chemicals
- Lighting and ventilation
- Waste disposal including effluent treatment.
- Good Manufacturing Practices (GMP)
Processor needs to implement H.A.C.C.P. system to control;

- Raw Materials including Raw milk by testing in own/approved laboratory for required parameters
- Raw Milk to be tested for residues as per RMP at prescribed frequency.
- Online process control to be conducted by competent personnel of the plant.
- Finish product control; test of samples are carried out by the unit in their own laboratory or E.I.C. Approved Laboratory as per buyer's requirement.
- Sanitary and Hygiene Control by testing sanitary samples in their own laboratory.
- The storage control
- Transportation control
- Documentation

**Surveillance by E.I.C. / E.I.A.s**

Three tier Surveillance System is being followed By EIC/EIAs to check the compliance to laid down requirements by the approved Milk unit.

**Monitoring by EIA official:**

- Verify the process control, product control,
- Verify sanitary and hygiene practice.
- Verify parameters tested as specified in the notification are within the tolerance limit and observe testing by laboratories.
- Verify the records
- Verify implementation of HACCP plan.
- Draw sample of raw milk, swabs from workers and equipments' in process and finish products for ensuring safety and wholesomeness of the product.

**Supervisory visit to verify**

- Compliance to norms by the processors
- Quality and correctness of monitoring by EIA officers

**Corporate Audit by EIC**

- Examine the operations of scheme by EIAs as per documented system.
- Visit by audit team at least 10% of the approved units.

**Some important requirements for dairy products**

**Microbiological criteria for milk products**

**A) Pathogenic micro organisms – should be absent**

- *Listeria monocytogenes*
- *Salmonella* spp.
- *Shigella* spp.
B) **Organisms indicating poor hygiene—within prescribed limits**

- *Staphylococcus aureus*
- *Eschericia coli*

C) **Indicator Organisms—within prescribed limits**

- Coliforms
- Plate Count

**Residue Monitoring Plan (RMP) - Testing of Raw Milk by Processor**

- Milk processing plants shall exercise suitable control on quality of incoming raw milk. They shall test or arrange to get tested the raw milk in outside EIC recognized laboratories for the following parameters as prescribed by EIC.

1. **Pesticide residues**
2. **Drugs**: Total residues antibiotic (as Beta Lactum)
3. **Heavy Metals**
   - a. Lead
   - b. Arsenic
   - c. Cadmium
   - d. Tin
   - e. Zinc
   - f. Mercury
4. **Aflatoxin**
   - a. Aflatoxin M1

**Issuance of certificate of inspection**

- The printed blank certificate of inspection is issued to the approved plant. The approved plant will issue the certificate of inspection for every export consignment & submit two copies of the same to the concern EIA. The certificate of inspection can be issued only by the authorized signatories of the plants. Validity of the certificate of inspection will be 45 days from the date of issue.

**Issuance of Health Certificate**

- The health certificate can be obtained by an approved plant for the products for which they are approved for, by making a request on a prescribed format to concerned EIA along with the following documents
  i. Copy of certificate of inspection for the concern consignment issued by the processor.
  ii. Testing data of residues of pesticides, drugs and heavy metals for the period of production of the consignment.
  iii. Laboratory test report for the additional parameters to be indicated in health certificate of clearly indicating about compliance of the consignment as per the requirement of importing country.

E.I.A.s. also draw the sample of raw milk from approved processing unit for testing the following parameters under residue monitoring plan (RMP).
<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>MRL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veterinary Drugs</td>
<td></td>
</tr>
<tr>
<td>• Chloramphenicol</td>
<td>ND</td>
</tr>
<tr>
<td>• Nitrofurans (including Metabolites)</td>
<td>ND</td>
</tr>
<tr>
<td>• Ronidazole</td>
<td>ND</td>
</tr>
<tr>
<td>• Albendazole</td>
<td>100ppb</td>
</tr>
<tr>
<td>• Fenbendazole</td>
<td>100ppb</td>
</tr>
<tr>
<td>Heavy Metals</td>
<td></td>
</tr>
<tr>
<td>• Lead</td>
<td>0.02 ppm</td>
</tr>
<tr>
<td>• Arsenic</td>
<td>0.1 ppm</td>
</tr>
<tr>
<td>• Mercury</td>
<td>1.0 ppm</td>
</tr>
<tr>
<td>• Tin</td>
<td>250 ppm</td>
</tr>
<tr>
<td>• Cadmium</td>
<td>1.5 ppm</td>
</tr>
<tr>
<td>• Zinc</td>
<td>50 ppm</td>
</tr>
<tr>
<td>Aflatoxin M1</td>
<td>0.5 ppb</td>
</tr>
<tr>
<td>Total Antibiotic as (Beta lactum)</td>
<td>10.0 ppb</td>
</tr>
<tr>
<td>Pesticide Residue</td>
<td></td>
</tr>
<tr>
<td>• Organochlorine Group</td>
<td>0.01 ppm</td>
</tr>
<tr>
<td>• Organophosphorus Group</td>
<td>0.01 ppm</td>
</tr>
</tbody>
</table>

The above parameters shall be tested as per methods given in the latest AOAC/Codex/Internationally recognized methods.

**MOUs/MRAs/Recognitions**

In order to reduce the amount of inspection at importing end also to minimize the rejection, EIC is working towards signing of equivalence agreements with major importing countries. Under these agreements, the inspection certificate system operated by EIC is recognized there by the certificate of conformity issued by concerned EIA in India for export will be honored in the importing country.

**International Recognitions**

Under the provisions of WTO Agreements, especially the SPS Agreement, several of India’s trading partners have imposed import control system based on international standards, particularly in food sector. These Agreements provide for recognition of the export certification system of member trading partners provided it meets the requirements of their import control. As the official export certification body of India, EIC’s certification has been recognized by several of India’s trading partners, while with others, dialogue for seeking recognition is presently in process.
Add Value or Perish: Experiences of GCMMF in Marketing of Value Added Products

MR. B. M. VYAS
Managing Director
Gujrat Cooperative Milk Marketing Federation Ltd., Anand, Gujarat

Introduction

The journey from the days of plain vanilla products and services to those of relentless and ceaseless value addition makes an interesting reading. It progresses through an intermesh of changing demographics, social systems and values, politico-economic matrices and evolving ways of doing business. When we speak of value, we are referring to attributes not intrinsic in a given product or service that a customer finds useful. As a corollary, the customer is willing to pay a premium for the product or service that she would not have paid had it been lacking in these attributes.

Why do we need to add value after all? Simply put, sans value addition, you cannot command a steady premium. Further, value addition creates loyalty among customers. However, there is another perspective to the issue. Milk is a perfect example of a perishable commodity. Given this, the producer is always at a disadvantageous position vis-à-vis the market. While shortage conditions during summer months may see good price realization, flush winter season would see fall in realization. However, the moment value is added to milk in the form of say milk powder, butter, ghee etc, the bargaining power of the producer increases appreciably. By adding value, we are effectively insulating the producer from the vagaries of the commodity market. Where the livelihoods of millions of farmers are bolstered by and dependent upon dairying, it is obviously of great importance to ensure that they receive fair returns for their produce all the year round.

The Early Days

If we consider the mid and late 1940s, the period featured a population on the brink of explosion, available food resources woefully inadequate to provide food security, thus the country depended substantially on imports for feeding its burgeoning population.

Table 1 : Availability of food grains in India

<table>
<thead>
<tr>
<th>Year</th>
<th>Total production (million tons)</th>
<th>Net availability (million tons)</th>
<th>Per capita availability (g/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951</td>
<td>51</td>
<td>44</td>
<td>337</td>
</tr>
<tr>
<td>1956</td>
<td>67</td>
<td>59</td>
<td>392</td>
</tr>
<tr>
<td>1961</td>
<td>82</td>
<td>72</td>
<td>430</td>
</tr>
<tr>
<td>1966</td>
<td>72</td>
<td>63</td>
<td>351</td>
</tr>
<tr>
<td>1971</td>
<td>108</td>
<td>95</td>
<td>473</td>
</tr>
<tr>
<td>1975</td>
<td>100</td>
<td>88</td>
<td>420</td>
</tr>
<tr>
<td>1978</td>
<td>126</td>
<td>110</td>
<td>475</td>
</tr>
<tr>
<td>1979</td>
<td>131</td>
<td>115</td>
<td>482</td>
</tr>
<tr>
<td>1980</td>
<td>132</td>
<td>116</td>
<td>470</td>
</tr>
</tbody>
</table>

Excluding oilseeds, sugar, roots, tubers, milk, and milk products
Sources: Bulletin of Food Statistics 1975, 1979; Agricultural Situation in India, 1980
Post independence, the leaders at the helm of the country had their work cut out for them ensuring food security. On the food grains’ front, the nation had to wait till the mid sixties for any substantial initiative. This is the time when the so called ‘Green Revolution’ brought about a quantum jump in availability of wheat and rice (and later on other crops) in the country.

Meanwhile, on the milk and milk products’ front, the farmers of Kheda district had already started a quite revolution. This revolution was so go a long way in giving shape to a movement that would eventually make India not only self sufficient in milk, but also the highest producer of milk in the world.

Table 2: Per Capita availability of milk

<table>
<thead>
<tr>
<th>Year</th>
<th>gm/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>132</td>
</tr>
<tr>
<td>1960</td>
<td>127</td>
</tr>
<tr>
<td>1968</td>
<td>113</td>
</tr>
<tr>
<td>1973</td>
<td>111</td>
</tr>
<tr>
<td>1980</td>
<td>128</td>
</tr>
<tr>
<td>1990</td>
<td>178</td>
</tr>
<tr>
<td>1992</td>
<td>192</td>
</tr>
<tr>
<td>1996</td>
<td>198</td>
</tr>
<tr>
<td>1997</td>
<td>200</td>
</tr>
<tr>
<td>1998</td>
<td>202</td>
</tr>
<tr>
<td>1999</td>
<td>203</td>
</tr>
<tr>
<td>2000</td>
<td>212</td>
</tr>
</tbody>
</table>

(Source: Dairy Industry Newsletter)

A New Concept in Dairying

What the farmers of Kheda achieved in the form of Amul pattern of cooperative dairying was nothing short of a new concept. Pre Amul, the dairy industry was basically hostage to a network of middlemen and commission agents who cornered the best part of revenues generated from milk business. Obviously, the farmer was invariably left holding the thin end of the stick. The private system of dairying may be represented as in Fig. 1.

The Amul Pattern brought in a new concept of dairying wherein the producer farmer had a direct interface with the consumer. This was achieved through direct control of the farmer member of the dairy cooperative over the hitherto esoteric functions of processing, marketing, brand building and management. The new system may be represented as in Fig. 2.

An important result of the Amul Pattern of dairying was the advent of a system of dynamic evolution. When the farmer came into direct contact with the market, she got direct and immediate access to feedback regarding customer requirements.

This not only sharpened her ability to respond and adapt very quickly to evolving customer tastes, but it also instilled into her the ability to anticipate and shape market requirements. Thus, the farmer not only became market driven, but also a market driver.
The Evolution of Amul

As already pointed out, the story of Amul is one of continual dynamic evolution. After its formation in 1946, Amul started transporting liquid milk to the Mumbai market by rail in mid 1950s. Here, the farmers of Kheda were actually delivering value to the customer in terms of place utility (Mumbai was a milk deficit market as always-totally dependent upon external lines of supply) and assured quality (the market was facing rampant adulteration in milk).

During the later 1950s, Amul pioneered the production of skimmed milk powder from buffalo milk – despite skepticism expressed by UNICEF. This opened the way for various powder-based value-added products in the ensuing years.

About the same time, Amul launched Butter in anticipation of market requirement. As everybody knows, Amul Butter has been a successful product by every yardstick. Thereafter, Amul has never failed to regale the customer with new launches answering or anticipating market requirements. This is clear from the table 3 below.
Fig. 2: The Amul pattern of dairying

Table 3: Product Launches from Amul

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Year of introduction</th>
<th>Products</th>
<th>Sr. No.</th>
<th>Year of introduction</th>
<th>Products</th>
</tr>
</thead>
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Source: GCMMF Archives

Opening Up of India

The year 1991 marked a watershed in the economic life of the country. India opened its doors to foreign investments, ideas and cultural mores. Increasing globalisation took place in a matrix of various important and shaping influences that may be summarized as follows:

- An increasingly well educated and youthful population
- Increasing disposable incomes
- Exposure to western culture and way of life through opening up of television, telecommunication and foreign travel
- Increasing rural incomes and consequent demand for modern products and services
- Increasing concerns about fitness and health
- Nuclear families and double income households
- Work life for both husband and wife getting busier by the day with little time available
for traditional activities like cooking, cleaning etc.

In this scenario, Amul was once again able to identify socio-economic trends and come up with the right answers to marketing questions. The increasing predilection for fresh and value added products for daily consumption in the market was met with the following measures:

• Rapid expansion of fresh milk market across the country
• Rapid launch of fresh, value added and ready to consume products like packaged curd, ice cream, flavoured milk, spiced buttermilk, soups etc.
• Deepening of distribution for better availability. This took place through generation of optimal synergies among the frozen, chilled, fresh and ambient channels
• Amul moved closer to the market by foraying into direct distribution through Amul parlours across the country
• More intense focus on the export market through offer of customized product mix to these markets
• Deeper studies on consumer mind-space leveraged for optimal brand positioning and packaging solutions

**Market Segmentation**

Post-1991 and owing to rapid socio-economic and cultural changes, the market has shown an increasing predilection for value added products. While marketing value added products market segmentation is a *sin qua non*. This is simply because different market segments have different requirements and therefore attach differing values to the same offering. We have used various criteria for market segmentation. They may be discussed as follows.

**Age Group & SEC Classification**

This is a very basic criterion for market segmentation and ensures that while we are offering products for different age groups, suitable modifications are made for catering to specific needs of SEC classes.

The above segmentation matrix is indicative and does not portray an exhaustive pigeonholing of the entire Amul portfolio on the age-SEC classification matrix, it gives an idea how we have gone about analyzing, anticipating and filling the need gaps in the market.

**Geography**

When we segment the market using the criterion of spatial phenomena, we use Geographic segmentation. However, spatial differentiation among markets may be analysed in different ways. Again, geographical segmentation is often overlaid with other criteria such as SEC classification, application, age etc. Some examples of this kind of segmentation exploited by us are as follows.

**Topography**

The country may be broadly divided into Hills, Plains and Coastal markets. Hills provide a peculiar problem of logistics and accessibility. As a result, these markets have requirements for robust packaging that can withstand rough transportation conditions. In addition, these markets need long shelf-life products since they are unable to be serviced daily by distributors who are generally based on the plains. Coastal markets feature fishermen who go for long fishing trips necessitating availability of food products that are convenient to use, dry in nature and compact in form. Amul has used this kind of segmentation for products like white
milk. Thus, long life milk in robust aseptic cartons has been successfully marketed in hills and coastal markets. On the other hand, transportation is not an issue in the markets on the plains. Therefore, Amul has adopted the strategy of marketing milk in plastic pouches in these markets – thus offering the benefits of freshness and lower prices.

**Land use**

On the basis of land usage and associated socio-cultural-economic attributes, markets may be segmented into Rural and Urban. Rural markets are often characterized by traditional preferences, lower purchasing power and stability of preferences (however, with increasing incomes and exposure to modern cultures, a sizable rural market is developing with tastes and requirements not very different from those of well educated urban customers).

Our traditional products like milk powders, butter and ghee find very good penetration into the Indian rural markets.

Urban markets are characterized by higher volatility of preferences, higher awareness about quality, experience and brand parameters, and image and health consciousness. Therefore, while Amul Vanilla ice cream in cups finds a good market in rural India, urban markets need ‘ice creams with an attitude’ such as Tricone, Frostik (Love at First Bite), Hum – Tum, Ice Cream Cake Magic, and Double Sundae etc.

In chocolates, rural markets purchase normal milk chocolate bars. However, urban household markets show preference for add-ons such as funky packaging, fruit and nuts etc. therefore, Amul launched sub-brands like Bindaaz, Fundoo etc. Further, urban children are more on the lookout for excitement and fun. Amul realized this need among them and launched Chocozoo – moulded chocolates in exciting animal shapes. This product was launched in
premium sealed tins for up market urban kids while the same product was made available in plastic containers to be sold lose at Rs.3.00 per piece for urban children from low income households. Well-educated urban market segments show a remarkable concern for ‘wellness’ products. Amul has catered to the health concerns of this segment with products like Slim Scoop Ice Cream, Amul Lite range of products etc.

Recently, a need was detected among the young, educated and upwardly mobile working couples and single member households to avail of the nutritional goodness of traditional products. However, this segment does not have the time at its disposal to prepare traditional products on its own. Amul offered Masti Spiced buttermilk in convenient aseptic packaging with great success to this segment. While the product was offered in 200ml packs for on-the-go and single consumption occasions, it was offered in 1000ml and 500ml packs to cater to the family requirements. Earlier, Amul had already offered products like Masti Dahi and Shrikhand in convenient and trendy packaging to this segment.

**Application**

On the basis of application, we have discovered the segments of Ingredients/Industrial market, Institutional market and Household market. Each of these segments has its own requirements in terms of pack-size, price, quality, specifications etc. While Amul markets Sweetened Condensed Milk in 280 kg barrels to the industrial market, it markets the same product in 7.5 kg tins to institutions like restaurants and in 400 gm EOE tins. Amul Ice Creams are sold in 5-liter packs to institutions (mainly caterers and restaurants) while it is sold in 1 liter packs for household consumption. Amul Ghee is sold in 190 kg barrels to the ingredients market while it is sold in smaller pack sizes to the household market. In the same way, Sagar SMP and Amulya in 25 Kg bags, While and Yellow Butter in 15 Kg packs etc. cater to the ingredients and institutional markets. For the household market, the same products are available in smaller pack-sizes and lower price points. Institutional requirement is not limited to simply larger units and lower unit prices. For example, Indian Airlines had requirement of a 3 gm sachet of Amulya with specific packaging and solubility requirements that Amul provided.

**Distribution**

Market segmentation can only provide the coordinates of a market. It has to backed by an effective distribution system for an organization to be able to exploit these markets. Amul relies on four distribution channels for making its products to various market segments:

**Frozen**

The deep frozen channel used for transportation and storage of ice creams, paneer, cheeses etc. Obviously, investments are higher in this channel as is the necessity of expertise in achieving and maintaining a temperature of -18°C. Products leveraging this channel are generally high value and therefore maintenance is of utmost significance. It consists of vehicles with freezing equipment (first, second and third leg) and cold rooms/freezers at all levels.

**Chilled**

This channel is used for transporting and storing products like butter, delicious bread spread etc. that need a temperature of about 0°C.

**Fresh**

Products like pouch milk, dahi, shrikhand are transported through this channel. Given the nature of the products bourn by this channel, frequency of movement and shortness of turnaround time is of crucial importance.
Ambient

Products that do not show temperature decay and that may be transported under ambient temperature conditions are carried through this channel. Examples are UHT milk and flavoured milk in aseptic cartons (UHT milk), spiced buttermilk, milk powders etc.

In order to reach each and every segment in the market, it is of great importance to widen, deepen and build synergies among the above distribution channels. For example, where ice cream reaches, the frozen channel may be leveraged to convey paneer and cheese. Where butter reaches, the chilled channel may be leveraged to convey liquid milk and dahi.

CONCLUSION

Today, every market segment started showing a preference for value added products. Almost every market segment today has started showing a discriminating ability towards quality value added and the willingness and ability to pay for the same. In this scenario, successful marketing becomes a question of not merely coming up with the right product, but also of an equally important matter of supplementing it with a flawless and seamless distribution network.

Further, consumer tastes and preferences are evolving at a more rapid pace with every passing day. While this is a function of opening up of our society to western influences, there is no escaping the one and only survival strategy keeping pace with the consumer and even beating the consumer mind to value addition.

Failure on any of the above counts would mean nothing less than incurring the impatience of the customer and losing the same to a competitor. Globalisation has seen the ingress of aggressive and well heeled MNCs who want a share in the increasingly attractive pie of the Indian food business. The only way of countering and getting the better of them is to quickly identify what comprises value for different and evolving market segments, and then to develop and offer the same at the right price and place before anyone else manages to do it.
Availability of Equipment and Emerging Technologies in Processing and Packaging of Dairy Products

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Introduction

India is number one milk producing country in the World. But not more than 15% of the total milk production is processed and converted to milk products including market milk in the organized sector. The process technology and advanced process equipments for milk powders, cheese, lactose, milk based beverages, and casein are available. The mechanization and advancement of technology is not achieved at a desired pace in common products namely market milk, ghee, table butter, indigenous sweetmeat etc. There are a few installations with considerable technological advancement for products like market milk, table butter, lactose, casein and milk powders. Many more such plants are now taking shape.

This paper aims at listing some of the advancements/new techniques employed in procurement, transportation and processing of milk and milk products. Constraints in employing advance technologies and the subject of clean milk procurement is also discussed.

Processing Concepts and Emerging Technologies

The requirement of processing and packaging of milk and milk products are consumer driven. We are giving below few concepts observed in processing major products:

Milk Reception in Cans

The use of rotary can washers has declined. Motorized can scrubbers and can washers up to 15 cans per minute serve the needs of can washing in can reception. For bigger dairy plant can washer of 600 cans/ hr and 900 cans/ hr are available. Automation for pH temperature and flow control are available now. Dock automation involving advanced MIS and report generation through PC based reception modules is becoming increasingly common. The reception efficiencies can now be monitored for every shift.

Pneumatic tipping of weigh bowls, auto tipping of cans, separate reception of cow/buffalo milk through large compartmentalized weigh bowls are some of the advancements in can reception systems. Focus on can reception is declining since can reception shall progressively reduce in size and capacity due to preference for more and more milk being received in tankers at dairy plant.

Milk Reception in Tankers

There are many installations of Automatic on line de-aeration systems in milk unloading lines in automated dairies. The preferred reception modules up to decanting rates of 40 even 50 KLPH are installed at some plants with auto sampling. The size of tanker is now becoming a limitation. Large size milk tanker of capacity 30 KL and above is not available in India. But attention is now to design and manufacture this size of tanker.

Mass flow meters are being used for tanker reception measurement. The tanker reception systems are fairly advanced in India but the tanker CIP is an major issue now. Automated CIP
systems are installed solutions are yet to be found for constraints like un-matching manhole covers etc.

**Basic Milk and Milk Product Processing Modules**

**Pasteurization**

High efficiency pasteurization modules up to 93 percent regeneration with glue free gasket plates are getting increasingly common in medium to large capacity dairy plants. There are plants designed with theoretical 95 percent regeneration as well, by inducting need based cream cooling with incoming raw milk. A few dairies are also talking about up building their pasteurization systems to meet the stringent USFDA standards. There is also a focus on energy saving configurations in pasteurization systems.

**Clarification**

Centrifugal clarifiers in raw milk/cold milk reception lines have been used by some processing plants. It has resulted in better clarification then is otherwise available through conventional straining and tri purpose centrifuges. It is also found effective in reducing the bacteriological load to some extent. Due to high capital cost it is not being actively considered.

**Homogenization**

Most of the dairies execute partial homogenization to prepare various types of milk in a batch process. Concept of on -line partial homogenization and lowering homogenization pressures is now finding place amongst present day manufacturers. There is an increasing trend of homogenizing toned and cow milk so as to improve its appearance, apparent consistency and whiteness in cow milk.

**Milk Separation and Auto Standardization**

Auto self-de-sludging separators for capacities of 20 KLPH and above have become quite common. PLC based fat standardization systems by remixing of cream to generate market milk of required composition are also working satisfactorily at number of installations. The sludge from separators and other centrifugal machines is presently being drained. The sludge sterilization systems wherever installed are not in use. There have been few enquiries on standardization systems for SNF in milk but the solution of serum standardization in raw milk to achieve desired SNF in market milk has been preferred over setting up complex SNF standardization systems.

**Bactofugation**

First bactofugated market milk with claims of extended shelf life and bacteriological superior product came up in the Indian market a few years back. It could not replicate much since the investment in bactofuge is difficult to justify unless the bactofugated product pays a good premium. The only concluding advantage it has given to the processors is to increase the marketing radius geographically. This is not a sufficient reason for its promotion since raw milk is increasingly available near to the market place in most of the areas.

More over there is a school of thought to arrest bacteria in the procurement process itself rather than to allow them and remove subsequently while processing. The former part though difficult, time consuming and may be more capital intensive is the only solution in log term to achieve the goal of receiving good quality milk at the dairy dock.
De-aeration/ De-odourisation Systems

Removal of incorporated air and volatile undesirable odors from milk is now being recognized as a process preference by Indian dairy processors. There are a few installations of pasteurisers incorporating deodorizers in India for yogurt and other products. Recently some trials were taken at a premier dairy to compare market milk produced with and without use of deodorizers. Many points have been scored in the sensory evaluation of milk produced with deodorization in circuit. The dairy plants using deodorization in the module meant for curd pasteurisers are now seriously contemplating putting deodorizer for market milk processing module as well.

Reconstitution - Recombination

While major emphasis is towards maximizing fresh milk input into the market, recombination and reconstitution is also practiced depending upon the requirement.

Continuous butter melting plant to handle requirements of large liquid milk dairies based on fat recombination has also been very successfully introduced along with a continuous tri blending process for SNF reconstitution. There is one large-scale installation working since last five years with a continuous block butter melting capacity of 2 TPH and powder reconstitution capacity of 7.5 TPH.

Processors are feeling the pressure of consumer preference in the present competitive market and there are instances where increase in total solids by addition of SNF and higher fat percentage is being inducted while keeping the price and milk brand same.

Ghee Manufacturing Systems

Ghee occupies predominant position amongst milk products in India. Most of the Indian ghee is produced through butter route and there are only a few installations where the cream is concentrated to 85% and above and converted to ghee by conventional boiling.

Pre stratification of molten butter to save energy in final boiling is now an integral part of process design. While melting of butter is mostly done in conventional butter melting vats a few installations exist on on-line butter melting. The conversion of block butter to molten butter and separation of moisture from molten butter aimed at minimizing moisture for evaporation in ghee manufacture. The recovery of serum solids is being considered by dairy producers across the country although the effect on lactone I component of flavor due to substantially reduced SNF for burning is still to be evaluated.

Centrifugal clarification of ghee is gaining ground and optical clarity of finished product is receiving increasing importance amongst processors.

SNF washing in concentrated cream route of ghee manufacture is still to be adopted by industry along with the process itself for ghee manufacture.

While continuous ghee making process has been reportedly developed, its commercial adoption is still awaited by Indian dairy industry.

There is an unexplored area of manufacturing butter oil and converting it to ghee thereby eliminating costly storage of white butter for the lean season use. Butter oil could also be a very suitable raw material for recombination of market milk, ice cream mixes and host of other applications.

Table Butter

Salted table butter still remains to be a product manufactured by very large dairy establishments due to the constraints of high processing cost, market and distribution network and the sophistication of the product itself.
It has been a very accepted notion that the table butter can be best produced in batch type butter churns and that continuous butter making is still not common. There are only few installations of continuous butter manufacturing in India with some of the big dairies. State of the art plant with a capacity of around 3.75 TPH with on-line packaging and end packaging equipment was set up in Gujarat. There were some problems with respect to throughput guarantees and consistency of operation. A new 2.5 tons per hour fully automated butter manufacturing, on-line molding, wrapping, auto cartooning and case packing installation with improved through put and consistent operation was subsequently set up. This plant produces butter of uniform consistency in a very hygienic environment.

The use of butter silo and on line butter pumping systems for table butter is presently there in a few installations and its worth in terms of consistent quality butter is being felt.

The need for reliable moisture monitoring and auto control system in table butter is long felt in lieu of the savings it gives to the processor. However there are no scientific studies available in terms of seasonal variation in cream characteristics. There is no very well defined system of cream processing, cream aging etc. This is a constraint in making a moisture control system operational in table butter manufacturing systems. One or two systems imported earlier by dairies also did not perform due to this bottleneck.

There is also a growing interest to look into products like spreadable butter, low fat butter and flavored / blended butter and their production in India is being debated at present.

There is also a great deal of interest butter reworking systems and concepts are being evolved to look into packing block table butter in flush and pack the same as per requirement all along the year. Many issues have come out and solution may be found in near future.

**Milk Powders**

There does not appear to be a growth in the segment of value added powders. In fact with more milk production there is a tendency to go for skim milk powder plants to balance excess procurement in flush season and even a no profit and no loss strategy to produce skim milk powder could win the processor a 100% milk procurement guarantee with continuously improving the quality milk.

There is a growing trend for go for multi nozzle atomization based spray drying plants with second stage fluid bed drying so as to produce consumer attractive agglomerated powder. Large capacity plants upto 70 TPD are available for making dairy whiteners and infant milk formula. The technology of lecithination in powders has been put in state of the art installations but still to be proved common.

Conveying of agglomerated powder and on-line to packaging systems is set up at several places and the results seem to be encouraging. There are certain complaints of powder breakage. With the invent of advanced technology in dense phase/pulse jet conveying, this problem has mostly been resolved. However high capital investment is still an issue to be resolved.

The experiment to produce malted milk foods on spray drying process seem to have concluded favorably with one very large plant coming up in Northern India. This is a very state of the art plant with latest technology.

Many recipes on infant milk formula and medicated foods are available, which could be implemented in a plant with versatile design features. In India only a few recipes are commonly used top produce infant milk food. Sufficient interest has now been evinced in this segment and formulated milk powders by dry/wet blending processes are being produced by well known brand names. There is no wonder if such experiments prove fruitful with adopting available quality technology and collaboration resulting in a variety of powder formulas.
It should not look surprising now for India to conceive powder plants that do not stop for months together and built up with a battery of evaporators and duplex concentrate handling arrangement at the drying end. Such plant would conceive three evaporators (any two working at a time while the third is in cleaning). The venturies on the dryer ceiling would have duplex set of nozzles with a facility to remove one set for cleaning without stopping the dryer.

A project execution in powder plant manufacturing results in a lot of time taken due to the requirement of high rise buildings. An outdoor installation of the drying system is the answer and a variety of experience available internationally should be utilized.

**Ice-cream**

In addition to smaller capacity plants there are 3-4 fully automatic ice cream and candy manufacturing lines commissioned and in production in the country. The extrusion lines and rotary automatic candy making and wrapping machines have already been put up in production. The equipment are largely imported. These plants have higher production capability, consistent product quality. However, the higher initial investment and lower end price are deterrent factors in establishment of such plants.

Frozen Desserts is another area evincing great interest in the country. However, production plants are still to come up. Ice-cream plants are at the verge of significant growth with willingness of large business houses to get into setting up large plants with a fair degree of automation.

**Traditional Milk Products**

This is one area where mechanization is still to take a grant leap. Very few and isolated installations are available.

Mechanized production of Khoa has been taken up in scraped surface heat exchangers/ evaporators and there are several installations. Real commercialization of Khoa manufacture is still to take place - the probable reason being that all the research has been focused on product processing with little or no emphasis on development of equipment. Batch type Shrikand manufacturing with pasteurization and on-line packaging is also available at several places.

Dahi or Indian Yoghurt is now getting mechanized very fast. Few installations are available both for producing Dahi in flexible packs as well as cups in the form of set yoghurt. Complete curd processing line including high heat pasteurization, homogenization and incubation/packaging is available.

Pasteurized butter milk and similar beverages are also finding place in the consumer market.

Seasonal nature of the milk-based sweet meat; availability of assured machine technology is some of the constraints for promotion of mechanization in this segment.

**Cheese**

Cheese, both traditional and processed verities are finding increasing acceptance both amongst the consumers and processors alike. There are one or two state of the art fully automatic process cheese installations in the country with high-speed packaging equipment. The equipment includes programmable closed type 15 KL capacity cheese vats, continuous cheddaring equipment, block forming towers, cheese cooking kettle and advanced packaging equipment.

The investment on such a big plant is justified and affordable only with established brand business houses and there is already a move by many cheese manufacturers to take up the manufacture in automatic plants in phases.
It would probably be important to induct only select cheese varieties to Indian consumers to simplify the equipment required and setting up cost economic cheese manufacturing ventures.

**Other Products**

There are a few installations on lactose, casein and whey derivatives in the country with a fairly advanced state of the art technology. With the continuous improvement in raw milk quality and confidence of high volume dairies many more plants are taking shape and the high sales and profit realization is now felt. A few indigenously engineered and manufactured installations are now in progress and taking a lead from the experience with these plants. It appears that this segment in Indian Dairy Industry is emerging. However it appears that with the growth of cheese manufacturing facilities, compulsion of handling whey would only be single largest factor determining the development of indigenous technology, related product configuration and its marketing.

**Process Controls & Automation**

There are several fully automatic computer desk controlled milk and milk product plants in the country. Such plants have resulted in improved efficiency, lower processing losses and better consistent and well-monitored product. Such installations are proving to be paying in the longer run but have put lot of tax on the plant managers to employ and continuously train skilled manpower. There are irritations in respect of teething instrumentation and control problems but the solutions are expected to emerge and that too on permanent basis.

**Milk and Milk Product Packaging**

Flavored milk as a beverage is available largely through batch type in bottle sterilization processes in India. Lot of interest has been shown towards manufacturing bottled milk/milk based beverages in continuous sterilization plants with glass/plastic bottles as the package. There are many plants operating in Europe. The enquiries for such systems are not making headway due to the high cost, imported technology and possibly higher operating cost. Bigger reason could also be the apprehension for the Indian market to accept these new package particularly plastic bottles.

UHT processed flavored milk in cartons is also available in Indian market through some brands.

Our consumer shall need an extended shelf life product something between the pasteurized milk and long life UHT milk. The efforts are needed to achieve this objective. There is a need for more information on process know-how. Availability of suitable packaging machine and packaging material is a matter that requires a lot of attention, information and research.

Like pasteurized pouch milk, the market needs to be looked into for UHT milk in flexible pouch to reduce cost and make milk available in milk deficient areas. There is only one working plant in India on UHT flexible film. It is now possible to manufacture suitable quality film from film manufacturing plants. The UHT flexible pouches can take a place as that of pasteurized milk pouches in near future.

Market milk dispensing and distribution is one of the biggest challenges to the industry and the bulk vending booths could play a significant role in minimizing the cost and ensuring satisfactory distribution. This is a very useful system but could not be implemented at many places on account of difficulties in managing such systems.

A new state of the art film manufacturing plant has been set up by NDDB to give a quality film using eight-color flexo - printing with food grade inks. PLC based milk pouch
filling machines are growing in numbers with many advanced features. Extra high-pressure crate washers with operation without steam and detergent have been set up and users have reported satisfactory results. Auto crate handling systems from the inlet of crate washer till inlet of cold store with minimum of human intervention has been set up and gaining acceptance, though slowly.

Tetra Pak is doing good work in promoting UHT processing and various packaging configurations. UHT milk in cartons is trying to establish itself in the Indian market but so far the success has been very limited. This has been largely due to not very consistent and proper quality of milk, higher cost of packaging material and not very aggressive marketing due to uncertainty of sustained production and cost benefit analysis.

Cup filling machines with multiple product filling options like yogurt/dahi, curd milk, lassi, sri-khand, cheese spread have started operating. The high speed cup filling machine may find many user dairy plants in near future.

High speed packaging lines for table butter duly incorporated with end packaging systems of cartooning and case packing have been established but still elude the industry due to high capital cost and typical issues associated with butter.

Lot of butter is packed in bulk blocks in the country yet there is no suitable block butter-packing machine. This system has to develop indigenously for the benefit of dairy industry.

**Clean Milk Procurement**

India is a diverse country with almost all variations present in milk sheds from scattered milk pockets to very rich milk producing locations.

Highest milk production has been achieved and now is the need to concentrate on improving the quality of raw milk.

Raw milk quality can be best improved by educating the producer, equipping him with necessary inputs and providing facilities to chill milk immediately and then ensuring and uninterrupted cold chain prior to processing clubbed up with best of hygienic practices.

It is our strong belief that there is no substitute to educating the producer and equipping him with affordable inputs for quality improvement in milk produce. Milking machines and mechanized milking systems are therefore not the priority and we have to first prepare and strengthen the farmer producers to increase their production levels with margins enough to afford mechanization and milking systems.

**The mission for milk procurement system can be best defined as**

“Milk should be hygienically handled, measured and paid for to suppliers satisfaction, chilled quickly to conserve quality and the operation must be aimed at increasing collection volumes at reasonable chilling costs”

Traditionally the available methods of chilling at village level include direct addition of ice, immersion cooling in cans, and ice plant aided milk chilling and conventional chilling centres.

New generation bulk chilling equipment includes instant milk chilling units, ice bank type bulk coolers, direct expansion type bulk coolers and continuous instant milk chilling units. Each type of bulk chilling unit offers its own merits and de-merits and accordingly offer a specific application. However by and large looking into the Indian milk scenario direct expansion type bulk-chilling unit presents the most adaptable system. These units are relatively simple, compact and offer low operating cost to the producer. They are based on direct expansion batch cooling based on freon as refrigerant in hermetically sealed compressor based condensing units.
Automatic milk collection centre modules have successfully come up to measure quality, weigh and pay the milk produce against collection. These modules together with bulk milk coolers shall present the future gadget for milk procurement in India and is expected to go a long way in improving the quality of the raw milk for processing.

Many new concepts like mobile bulk milk chilling units, immersion coolers etc. are under discussion for adoption to various situations in Indian milk shed.

**Conclusion and Role of R&D Institutions**

Some of the relatively new processing concepts and equipment have been mentioned in the paper. R&D institutions in the country in the field of dairy processing have done several commendable works but unfortunately it has largely remained in isolation without exposure to the industry. The reason may be largely due to unwillingness on the part of industry to take such systems whole-heartedly with associated risks.

It can also be mentioned that the research in India has largely concentrated on product development and processing and little to no emphasis has been given to the development of equipment to translate the results of process development. Unless the situation improves the dairy industry would be using more and more of imported know how and equipment at high cost which itself would be limiting its propagation. We need to strike a balance of co-operation and ensure that our vision is rightly placed with best solution for mutual benefit of industry, R&D institution and ultimately to the welfare and taste of our consumers.
Development in Milk Powder Technology

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Development in Milk Powder Technology

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(Formally L&T - Nirolimited) NIRO
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NDRI, Karnal

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DAIRY PRODUCTS
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Nondestructive Methods for Quality Evaluation of Dairy and Food Products

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Consumers are now more conscious about quality and source of their foods including dairy products. Attempts made to determine the quality of food materials are numerous, but most of them are destructive in nature. In recent years, nondestructive methods of quality evaluation have gained momentum and a considerable attempts have been made to develop them. This lecture describes some of the important nondestructive methods: magnetic resonance imaging, x-ray computer tomography, visual spectroscopy and colour measurement, near infrared spectroscopy and a few other important techniques for determination of different quality attributes with emphasis on dairy and food products including fruits and vegetables, and discusses their pros and cons for practical exploitation in the country.

Quality conscious consumers nowadays want to get assured about various quality attributes of food items before they purchase. Fruits, vegetables and milk are increasing in popularity in the daily diets in both developed and developing countries. Products’ quality and its measurement techniques are thus naturally extremely important. The decisions concerning the constituents, level of freshness, ripeness, and many other quality parameters are based mostly on subjective and visual inspection of the foods’ external appearance. Several nondestructive techniques for quality evaluation have been developed based on the detection of various physical properties that correlate well with certain factors of a product. The quality of foods including milk and milk products is mostly based on constituents, purity; i.e., levels of adulterants; color, gloss, flavor, firmness, texture, taste and freedom from external as well as internal defects. Numerous techniques for evaluating these parameters are now available commercially, but most of them are destructive in nature. Internal quality factors of fruits such as maturity, sugar content, acidity, oil content, and internal defects, however, are difficult to evaluate.

Methods are needed to better predict the internal quality of fruits, vegetables, constituents of foods and level of adulterants, if any, without destroying the sample. Recently, there has been as increasing interest in nondestructive methods of quality evaluation, and a considerable amount of effort has been made in that direction. But the real problem is how these methods are to be exploited practically and what the difficulties are in implementing them. The objective of the present paper is thus to give exposure of recent nondestructive methods such as nuclear magnetic resonance, x-ray computed tomography, near-infrared spectroscopy and some other important methods to the stakeholders of food industry in India and to evaluate their pros and cons for suitability in commercial application.

Nuclear Magnetic Resonance (NMR) Techniques

The nuclear magnetic resonance technique, often referred as magnetic resonance imaging (MRI), involves resonant magnetic energy absorption by nuclei placed in an alternating magnetic field. The amount of energy absorbed by the nuclei is directly proportional to the number of a particular nucleus in the sample such as the protons in water oil. The theory of NMR is presented in detail elsewhere (Farrar & Becker, 1971). The basic concepts, types of pulsed experiments and the type of information that can be extracted from these experiments are described. Information on experimentation, assembling hardware, conducting laboratory tests and interpreting the results is also available from Fukushima and Roeder (1981). These authors also provided detailed theory for better understanding of what a scientist should seek and what he might expect to find out by using NMR.
There are many applications of NMR in agriculture (Rollwitz, 1984). The simplest among them is the determination of moisture and oil content (Mousseri et al., 1974, Leung et al., 1976; Miller et al., 1980; Brosio et al., 1978; Rollwitz and Persyn, 1971). But the NMR response many times is not clear and poses problems especially when constituents other than water are present in the material (Steinberg & Richardson, 1996). Besides the established relationship between the moisture and output of NMR experiments, various other facts helpful in determining the quality of food materials without destroying them are available in the literature.

Selections of chocolate confectionary products can be made non-invasively by three-dimensional magnetic resonance imaging (Miquel et al., 1998); using a spin echo pulse sequence, 128x64x64 data sets were acquired with either a 5-or 20-ms echo time, 500-ms repetition time and signal averages, in total 2-h scan time. Such images localize and distinguish between the constituents, and visualize both the internal and external structure of matter.

Most perishable food products are now marketed in packaged form. To increase the marketability longer shelf life is needed and this is achieved by freezing and secondary processing of the food. During freezing it is natural that ice will form within the food that may change its characteristics. Ice formation during food freezing can be examined using the NMRI method as the formation of ice has been seen to reduce the spatially located NMR signal. The characteristics of a food can be better controlled as MRI can serve to assess freezing times and the food structure during the freezing process (Kerr et al., 1998). The secondary processing changes almost all characteristics of a food, such as physical and aerodynamic (Jha & Kachru, 1998), thermal and hygroscopic properties (Jha & Prasad, 1993; Jha 1999), which in turn, change its key acceptability factors, i.e. sensory texture and taste. The sensory texture of cooked food such as potatoes has been predicted using the NMRI technique (Thybu et al., 2000). In addition, NMR image intensity, the ratio of the oil and water resonance peaks of the one-dimensional NMR spectrum, and both the spin-lattice relaxation time and spin-spin relaxation time of water in the fruit are correlated with maturity of a fruit like avocado before harvesting (Chen et al., 1993). This important finding has desirable features for high speed sorting using a surface-coil NMR probe that determine the oil/water resonance peak ratio of the signal from one region in an intact fruit.

An on-line nuclear magnetic resonance quality evaluation sensor has recently been designed, constructed and tested (Kim et al., 1999). The device consists of a super-conducting magnet with a 20mm diameter surface coil and a 150 mm diameter imaging coil coupled to a conveyor system. These spectra were used to measure the oil/water ration in avocados and this ratio correlated to percent dry weight. One-dimensional magnetic resonance images of cherries were later used to detect the presence of pits inside.

**X-ray and Computerized Tomography (CT)**

X-ray imaging is an established technique to detect strongly attenuating materials and has been applied to a number of inspection applications within the agricultural and food industries. In particular, there are many applications within the biological sciences where we wish to detect weakly attenuating materials against similar background material.

X-ray computed tomography (CT) has been used to image interior regions of apples with varying moisture and, to a limited extent, density states (Tollner et al., 1992). The images were actually maps of x-ray absorption of fruit cross sections. X-ray absorption properties were evaluated using normal apples alternatively canned and sequentially freeze-dried, fruit affected by water core disorder, and normal apples freeze-dried to varying levels. The results suggested that internal differences in x-ray absorption within scans of fruit cross-sections are largely associated with differences in volumetric water content. Similarly, the physiological constituents have been monitored in peaches by CT methods in which x-ray
absorbed by the peaches is expressed in CT number and used as an index for measuring the changes in internal quality of the fruit (Barcelon et al., 1999). Relationships between the CT number and the physiological contents were determined and it was concluded that x-ray CT imaging could be an effective tool in the evaluation of peach internal quality. In another study, the potential for Compton scattered x-rays in food inspection was evaluated by imaging the density variation across a food material by measuring the Compton scatter profile across a food material by measuring the Compton scatter profile across polystyrenespheres with internal voids (MacFarlane et al., 2000). In this study particular attention was paid to simulate the obscuring influence of multiple scatter. The simulated result was found to be in close agreement with the experimental observation. Some experimental test sample of a Perspex block with various embedded soft materials showed that care should be taken to ensure that the transmission image is taken with x-ray within an appropriate energy range (Zwiggelaar et al., 1997). For low Z materials the contrasts between the materials became more pronounced at lower x-ray energies. If more than one soft material has to be distinguished from the surrounding area it may be advantageous to image over a range of x-ray energies.

**Visual Spectroscopy and Colour Measurements**

Colour measurement is now little bit old technique to check the quality of any items in terms of appearance. It has also been tested for assessing the ripeness of fruits and measurement of aesthetic appearances of dairy products. Recently many works have been reported to correlate the internal quality such as total soluble solids contents, maturity of fruits in tree and sweetness of intact fruits using Hunter colour values and reflectance spectra in visual range of wavelengths (Jha et al, 2005 and 2006). This in fact is possible through rigorous analysis of data and modeling for a huge number of samples of varied nature.

**Near-infrared Spectroscopy**

The use of near-infrared spectroscopy as rapid and often nondestructive technique for measuring the composition of biological materials has been demonstrated for many commodities. This method is no longer new; as it started in early 1970 in Japan (Kawano, 1998), Just after some reports from America. Even an official method to determine the protein content of wheat is available (AACC, 1983). The National Food Research Institute (NFRI), Tsukuba has since become a leading institute in NIR research in Japan and has played a pivotal role in expanding near-infrared spectroscopy technology all over the country (Iwamoto et al., 1995). In Japan, NIR as a nondestructive method for quality evaluation was started for the determination of sugar content in intact peaches, Satsuma orange and similar other soluble solids (Kawano, 1994).

To determine the solid content of cantaloupe Dull et al. (1989) used NIR light at 884 nm and 913 nm. Initially the correlation of their findings was poor mainly due to light losses. Later, Dull and Birth (1989) modified the earlier method and applied it to honey dew melons; the improved methods showed better correlation. Similarly, a nondestructive optical method for determining the internal quality of intact peaches and nectarines was investigated (Slaughter, 1995). Based upon visible and near-infrared spectrophotometer techniques, the method was capable of simultaneously predicting the soluble solid content, sucrose content, sorbitol content, etc. of intact peaches and nectarines was investigated (Slaughter, 1995). Based upon visible and near-infrared spectrophotometer techniques, the method was capable of simultaneously predicting the soluble solid content, sucrose content, sorbitol content, etc. of intact peaches and nectarines, and required no sample preparation.

Now various NIR spectrometers are available and are being used commercially. Some modifications in these available spectrometers, especially for holding the intact samples, are reported (Kawano et al., 1992; 1993). In the same sample holding a test tube for holding
liquid food such as milk was also used to determine fat content (Chen et al., 1999). Recently a low cost NIR spectrometer has been used to estimate the soluble solids and dry matter content of kiwifruit (Osborne & Kunlemeyer, 1999). Errors are within the permissible limit and the time required for obtaining data has been reduced. The influence of sample temperature on the NIR calibration equation was also evaluated and a compensation curve for the sample temperature was developed (Kawano et al., 1995) to rectify the result.

Now detection of almost all adulterants in milk in single stroke (Jha and matsuoka, 2004) and composition of milk and effect of somatic cell count on determination of milk constituents are very accurately determined (Tsenkova et al 2001). Similarly taste of tomato juice in terms of acid-brix ratio can be determined with high accuracy (Jha and Matsuoka 2004). NIR spectroscopy in fact is the most suited technique for nondestructive analysis of dairy products.

**Miscellaneous Techniques**

Quality attributes such as invisible surface bruises, color, gloss, firmness, density, volume expansion of processed food etc are also important (Jha & Prasad, 1996). Often consumers select food materials, particularly fruits and vegetables by judging these parameters visually. Multiple efforts have been made to determine these parameters visually. A fluorescence technique was used to detect invisible surface bruises on Satsuma mandarins (Uozumi et al., 1987). The authors have also tested this method successfully to know the freshness of cucumbers and eggs and found it very useful for detecting the freshness of agricultural produce.

Matsuoka et al., (1995) measured the gloss of eggplant by a spectral radiometer system and found or to be a viable parameter for determining freshness. They observed remarkable change in relative spectral reflectance values after 48 h. Later, they compares their evaluation by eye in a sorting house with the integrated results of relative spectral reflectance in the visible range and found that the gloss on the surface differs with light and is caused by round and adhesives substances on the epidermal cells (Matsuoka et al., 1996).

A unique gloss meter for measuring the gloss of curved surfaces was used in parallel with a conventional, flat surface gloss meter to measure peel gloss of ripening banana (Ward & Nussinovitch, 1996). Usually banana ripeness is judged by the color of the peel. The new gloss meter is able to measure the peel correctly which helps in predicting the correct time and level of ripening. This is also able to measure the gloss of other fruits and vegetables such as green bell pepper, orange, tomato, eggplant and onion (Nussinovitch et al., 1996).

Glossiness and color, in fact, are the only visual attributes for measuring the quality of fruits and vegetables. Another property that helps a consumer in deciding the quality is firmness. Takao (1998) developed a fruit hardness tester that can measure the firmness of kiwifruit nondestructively. The tester is called a ‘HIT counter’ after the three words, hardness, immaturity and texture. By just setting the sample in the tester, the amount of change in shape is measured and a digital reading within a few seconds indicates about the freshness. Based on the same principal another on-line prototype HIT counter, fruit hardness sorting machine has also been developed (Takao & Omori, 1991). The relationship between density and internal quality of watermelon can also be determined. An optimum range of density was first determined and then a new automatic density sorting system was develops and then a new automatic density sorting system was developed to measure the hollowness of a watermelons with cavities or deteriorated porous flesh to be removed and permits estimation of the soluble solid content of this fruits. Using gloss and other physical parameters such as stiffness and density, Jha and Matsuoka, 2002 have also determined the freshness of eggplants and have correlated it very easily with the day to day price in vegetable mandis.
Neural networks have lately gained in popularity as an alternative to regression models to regression models to characterize the biological process. Their decision-making capabilities can best to used in image analysis of biological products where the shape and size classification is not governed by any mathematical function. Many neural network classifiers have been used and evaluated for classifying agricultural products, but multi-layer neural network classifiers perform such tasks best (Jayas et al., 2000). Recently one scientist used a gamma-absorption techniques combined with a scanning device for continuous non-destructive crop mass and growth measurement in the field (Gutezeit, 200).

Most important in this study was the accuracy of the measurement, which was found to be in agreement with the direct weighting system. This method has made it possible to assess the reaction of plants and their dependence on environmental factors by growth analysis.

Conclusions

Determination of quality of any food material including milk and milk products is actually a complex problem that requires a variety of specific sensor, more than an accumulation of simple sensor. Various techniques are being tried. IMR, x-ray CT and NIR techniques may be useful for a large volume of work in agriculture, especially for evaluation of qualities such as maturity, internal quality of fruit and conditions of food materials after processing, level of adulterants and useful constituents. These techniques, although give a correct picture and precise measurement of parameters, are not convenient for small business except NIR and visual spectroscopy. Their high cost restricts application to large entrepreneurs and developed countries only.

Two examples of the use of x-ray imaging relevant to the agricultural and food industries have been given, notably in the inspection of vegetables and food materials using low energy x-ray imaging and in the inspection and control of dynamic processes. The x-ray imaging results have been compared with the full three-dimensional information obtained by computer tomography. The CT results show more detail in the test sample than the single transmission image and detail in the inspection of materials of variable shape usually encountered in the agricultural and food industry. The imaging techniques MRI and x-ray CT are able to show only the internal structure of the material, not the compositional of nutritional details, whereas NIR and visual spectroscopy techniques are very successfully being used to determine the compositional quality of a food and can be used even at farm. However, it is not yet possible to produce an image of the internal physical quality of fruits and vegetables. All techniques are costly because most of the expertise is imported. Central Institute of Post-harvest Engineering and Technology (CIPHET), Ludhiana has taken the lead by initiating R & D works in the country about four years ago. Dairy and food processing industries and other research organizations should also work together to develop such type of instrumentation indigenously.

References


Propionibacteria: A New Member in Probiotic Family

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As early as 1906, Von Freudenreich and Orla-Jensen had isolated various bacteria from cheese, among them bacteria producing propionic acid were named Propionibacterium. These bacteria are classified within the Gram positive group in the subdivision of Actinomycetes, which groups together the numerous species with high G+C content. Dairy or classical propionibacteria found in raw milk and other dairy products range from $10^2$ to $10^4$ cfu/ml. Propionibacteria can grow in milk, though they preferentially use lactate as carbon source, they can also use lactose. However, their growth in milk is relatively reduced due to their weak proteolytic activity.

The propionibacteria are probably best known for their role as dairy starter cultures, in which they produce the characteristic eyes and flavour of Swiss-type cheeses. The fermentation of lactose to lactic acid by the starter streptococci and lactobacilli provides the substrate for fermentation by the propionibacteria. The characteristic flavour of Swiss cheese is due, in part, to the production of short chain fatty acids, amino acids, and metabolic intermediates by the propionibacteria (Langsrud et al., 1978). The rates of growth and carbon dioxide production by this secondary flora are critical in determining the size and distribution of holes (eyes) in the cheese. In addition to contributing to flavour, the propionic and acetic acids produced by propionibacteria are inhibitory to molds, yeasts and some bacteria. The presence of these organic acids is known to improve the shelf-life of fermented products.

When selecting a new microbial strain for application in probiotic food products, the first constraint is that it must be a strain that is Generally Recognized as Safe (GRAS) (Havenaar et al., 1992). Like Lactobacillus species, dairy propionibacteria have been used as starter cultures in the dairy industry for a long time, and are considered safe for human consumption (Reinbold, 1985; Grant and Salminen, 1998). Dairy propionibacteria, which include Propionibacterium freudenreichii, P. jensenii, P. acidopropionici and P. thoenii, have recently shown potential probiotic effects, such as the production of propionic acid, bacteriocins, vitamin B$_12$ (Holo et al., 2002; Hugenholtz et al., 2002), synthesis of â-galactosidase enzyme (Zarate et al., 2000), growth stimulation of bifidobacteria (Kaneko et al., 1994), and favourable effects on lipid metabolism and the immune system of hosts (Perez-Chaia et al., 1995). To survive in the human gastrointestinal tract microorganisms must endure numerous environmental extremes, variations in pH, low oxygen levels, nutrient limitation and elevated osmolarity - all constitute potential impediments to survival. But following pre-requisites are considered to make a bacterium to be a member of Probiotic Family:

1. Capacity of transit tolerance to the upper gastrointestinal tract conditions (Acid Tolerance).
2. Surveilllance during small intestine passage (Bile and Pancreatic secretion resistance).
3. Ability to maintain and adhesion in GI tract of the host
4. Ability to show one or more functional attributes to the host like (Anticarcinogenic, Anti hypertensive, Antibacterial or immunomodulation etc.)

Although at present propionibacteria are not extensively commercialized as probiotics, it appears that they do have probiotic effects. This probiotic action depends on the production of propionic acid, bacteriocins, folacin, vitamins and their stimulatory effect on the growth of other beneficial bacteria. In view of the importance of these bacteria as dairy starter, and their role in antimetabolites and nutraceuticals’ production, we examined the presence of
these bacteria in raw milk and various dairy products to isolate some potent probiotic strains of *Propionibacterium* spp. After screening a large number of strains we could able to list three isolates which are bacteriocinogenic in nature and have all pre-requisites to serve as probiotic organisms.

**Acid Tolerance of Dairy Propionibacteria**

Acidification is widely used in the food industry as a means of preservation, and prevents spoilage by contaminating microorganisms. Fermentation of lactose by lactic acid bacteria in dairy products, in particular, leads to the accumulation of the end-product lactic acid. Furthermore, bacteria provided in fermented food are exposed in the human stomach to hydrochloric acid, lowering the pH to values around 1–2. Adaptation to acidic conditions thus seems necessary for efficient dairy starters. It is also of prime necessity for bacteria, either detrimental (pathogenic) or beneficial (probiotic), in order to reach the intestine.

Probiotic bacteria that are delivered through food systems have to firstly survive during the transit through the upper gastrointestinal tract, and then persist in the gut to provide beneficial effects for the host (Chou and Weimer, 1999). In order to be used as potential probiotics, dairy propionibacteria strains need to be screened for their capacity of transit tolerance to the upper gastrointestinal tract conditions. The low pH of the stomach and the antimicrobial action of pepsin are known to provide an effective barrier against entry of bacteria into the intestinal tract (Holzapfel et al., 1998). The pH of the stomach could be as low as pH 1.5 (Lankaputhra and Shah, 1995), or as high as pH 6 or above after food intake, but generally ranges from pH 2.5 to pH 3.5 (Holzapfel et al., 1998). The nature of food in the stomach affects the transit time through the stomach. Normally, food remains in the stomach between 2 and 4 h, However, liquids empty from the stomach faster than solids, and only take about 20 min to pass through the stomach (GastroNet Australia, 2001).

The Gram-positive, anaerobic aero-tolerant bacterium *Propionibacterium freudenreichii* has to cope with injurious stresses linked to the manufacture of Swiss-type cheeses. During this process, it has to cope with thermal treatment (52 °C, 30 to 60 min), slightly acidic environments (down to pH 5.2, caused by the starter lactic acid bacteria) and saline stress caused by immersion (48 to 72 h) in saturated brine. Only after these steps do the propionibacteria grow, convert the lactic acid to propionic and acetic acids as well as CO₂, leading to the characteristic flavor and the opening of Swiss-type cheeses. With this stress concept Jan et al., (2000) investigated the acid stress susceptibility and adaptation in a strain of *P. freudenreichii* subsp. *shermanii* used in Swiss-type cheese manufacture and found that the bacteria was able to survive as low as pH 2.0. In similar study, we were able to demonstrate high acid tolerance in case of propionibacteria isolated from raw milk (Chaudhary, 2005). The ability of bacteriocinogenic propionibacteria to survive at low pH was investigated. The PAB isolates 40, 51 and 53 were allowed to grow at various pH values in Yeast Extract Lactate medium. Optimal growth was observed in the pH range 6 to 7.5. However, isolates 40, 51 and 53 were able to survive at pH values below pH 5. Log-phase harvested bacteria were exposed for 0 to 120 min to different pHs (below 4) in acidified lactate broth and cell viability was monitored during this challenge period as well as after 12 and 24 h. While no significant loss of viability was observed at pH 3 or 2.5, exponential cell death occurred in more acidic environments. A 2-log decrease in cell viability was observed at pH 1 in case of *P. freudenreichii* 40 after 2 h and a 6-log decrease after 12 h. However, amongst the three PAB cultures the survival of isolate 53 was highest at any of the pH values.

Relatively higher tolerance towards acid stress is quite promising for the use of dairy propionibacteria as a probiotic food complement. The level of protection was higher than that described for other bacteria (Jan et al., 2000).
Bile Tolerance of Dairy Propionibacteria

Another barrier probiotic bacteria must survive is the small intestine. The adverse conditions of the small intestine include the presence of bile salts and pancreatin (Floch et al., 1972). The transit time of food through the small intestine is generally between 1 and 4 h (Smith, 1995). The pH of the small intestine is around pH 8.0. A concentration of 0.15–0.3% of bile salt has been recommended as a suitable concentration for selecting probiotic bacteria for human use (Goldin and Gorbach, 1992). Food is the common delivery system for probiotic bacteria. Food and food ingredients have been shown to protect probiotic bacteria from acid conditions and enhance gastric survival. In addition to resistance to low pH, adhesion to gut epithelial tissue and production of antimicrobial substances, resistance to bile toxicity is one of the criteria used to select probiotic strains that would potentially be capable of performing effectively in the gastrointestinal tract. Recently, Leverrier et al., (2003) reported that the age of the culture greatly determines the digestive stress tolerance of propionibacteria. Indeed, stationary phase cells were shown to be more tolerant to different stresses than exponentially growing ones. In our study isolate no. 51 was found to be most sensitive to bile treatment as 3-log reduction in growth was observed at 0.5% oxgall concentration after 4 h. Other two isolates 40 and 53 exhibited minor reduction in growth (only 1.5-log) after same treatment. Interestingly, there was no effect of 0.3% oxgall in case of P. freudenreichii 53 while isolate 40 and 51 were reduced by 1-log cycle at this oxgall concentration.

Cell Surface Hydrophobicity

Another important in vitro test for studying the probiotic nature of bacteria is the hydrophobicity test based on the nature of their cell surface involved in interaction with phagocytes, adherence to non-wetable solid surfaces, partitioning at liquid : liquid and liquid : air interfaces. The hydrophobicity to hydrocarbons is an important feature of probiotic Lactobacillus cell surface. In this investigation, the hydrophobicity of our propionibacterial isolates was determined with three common hydrocarbons namely hexadecane, xylene and n-octane. The results concerning the hydrophobicity of the test propionibacterial cultures 40, 51 and 53 are given in the following table.

Table 1. Cell surface hydrophobicities of propionibacteria strains with various hydrocarbons

<table>
<thead>
<tr>
<th>Culture No.</th>
<th>Initial O.D.</th>
<th>Final O.D.</th>
<th>% Hydrophobicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hexadecane</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>0.501</td>
<td>0.452</td>
<td>9.78</td>
</tr>
<tr>
<td>51</td>
<td>0.500</td>
<td>0.415</td>
<td>17.0</td>
</tr>
<tr>
<td>53</td>
<td>0.501</td>
<td>0.338</td>
<td>32.54</td>
</tr>
<tr>
<td>Xylene</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>0.502</td>
<td>0.484</td>
<td>3.58</td>
</tr>
<tr>
<td>51</td>
<td>0.501</td>
<td>0.455</td>
<td>9.18</td>
</tr>
<tr>
<td>53</td>
<td>0.502</td>
<td>0.361</td>
<td>28.08</td>
</tr>
<tr>
<td>n-Octane</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>0.500</td>
<td>0.481</td>
<td>3.80</td>
</tr>
<tr>
<td>51</td>
<td>0.500</td>
<td>0.468</td>
<td>6.40</td>
</tr>
<tr>
<td>53</td>
<td>0.501</td>
<td>0.388</td>
<td>22.55</td>
</tr>
</tbody>
</table>
Percent hydrophobicity of individual test cultures with three different hydrocarbons viz. hexadecane, xylene and n-octane varied from hydrocarbon to hydrocarbon which suggested the variable interface of the test hydrocarbons. For xylene and n-octane 40 and 51 strains gave 3.58, 9.18 and 3.80, 6.40, respectively while strain 53 provided almost constant percent hydrophobicity ranging from 22.55 to 32.54.

**Effect of Propionibacterium 53 on the coliform counts of mice GI tract**

In order to carry out such a study, the mice were adapted to normal diet and sterilized milk instead of water. After first week two different bacterial groups (group I and group II) were fed with normal basal diet and milk supplemented with *P. freudenreichii* 53. The *P. freudenreichii* 53 was selected on the basis of its ability to produce most potent bacteriocin, acid and bile tolerance and highest â-D-galactosidase activity in the presence and absence of bile salts. Both the bacterial group were fed at the rate of $10^7$ cells/ml and $10^9$ cells/ml, respectively. The effect of *P. freudenreichii* 53 in mice model on coliforms and weight gain was studied.

No dairy propionibacteria were detected in the mice feaces of both groups prior to providing *P. freudenreichii* 53 in their milk. At the second test time (after 7 days feeding with *P. freudenreichii* 53), the dairy propionibacteria level in the feaces of the group II increased to an 8-log value and remained at the level of 8-log to 9-log value until the end of the experiment (feeding for 21 days). However, no propionibacteria were obtained from the feaces of group I and control mice. At 0 day, the coliform count was estimated about 8-log cycle. Interestingly, reduction in coliforms was observed with the advancement of feeding and decreased to 5-log cycle on 21st day of feeding.

During the course of feeding, every week individual body weight of mice was determined and average weight for the particular group was estimated. No significant change in weight was observed between control and group I while in group II, the weight gain was observed as compared to other groups. In case of control and group I, average weight of mouse was estimated 42 g and 45 g while in group II to this average weight increased to 51 g.

**Conclusions**

There is a good case for the consideration of *Propionibacterium* spp. strains as potential probiotic organisms. The dairy species offer an interesting opportunity as novel probiotic organisms with the most obvious advantage being that they are considered safe for ingestion (due to their use in dairy foods). As more new and novel strains of probiotics are developed, the requirement for more regulated guidelines for probiotic needs to be addressed. Using the criteria currently available, propionibacteria of dairy origin have potential for application in human foods. These bacteria survived the gastrointestinal tract of the mice model, without any detectable adverse affects. It is unlikely that these bacteria will cause adverse affects in any other animal species, including humans. However, before application further clinical trials need to be undertaken to show some form of beneficial effect from the ingestion of these strains via probiotic foods.

**References**


Role of Membrane Processing in Value Addition of Dairy Products

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1. INTRODUCTION

Born at the end of the sixties, application of membrane processes in the dairy industry are now largely spread out, particularly after the commercialization of high mechanical and physico-chemical resistant mineral membranes. Membrane separation processes have presented new possibilities for the production of newer intermediate products that can be used for value addition in dairy and food products. The membrane filtration processes currently available include reverse osmosis (RO), nanofiltration (NF), ultrafiltration (UF), microfiltration (MF) and electrodialysis.

2. ULTRAFILTRATION PROCESS

This process typically employs membranes with molecular cut-off in the range of 10000 - 75000 D. During the last over three decades, UF technology has increasingly been used in the dairy industry because of many inherent advantages viz., saving on energy, improved yield of protein, enhanced nutritive value of the product and availability of a ‘sterile’ lactose stream in the form of permeate. One of the major benefits of UF technology is its ability to retain whey proteins, that are normally lost in whey in traditional manufacturing processes of cheese, chhana, paneer.

2.1. HIGH PROTEIN/HIGH CALCIUM DIET

Ultrafiltration process is employed to manufacture high protein high calcium diet. High protein diet is required for weight gain purposes. Adequate protein is also required during the critical periods of tooth formation. Similarly for the proper growth of the foetus during pregnancy high quality protein is needed. The high protein diet may also be given to patients when diarrhoea stops, and patients begin to tolerate food, the food given should be low in fiber and concentrated in protein and calories. During operation moderate or severe tissue damage leads to an increased excretion of nitrogen and often to considerable loss of body protein, fever, infections, poor circulations, and trauma accelerate nitrogen loss further.

By the application of UF, it is possible to make high protein milk. By applying the concentration factor to 1.5:1 the protein may be increased to 4.8-4.9 %. A wide range of novel in container sterilised milk concentrates have been developed from ultrafiltered skim milk with a shelf life above one year that be used for sports persons and for old people.

2.2 LOW LACTOSE POWDER

Lactose intolerance is a global problem. There are people with total lack of lactase activity or very small amounts of this enzyme. Ultrafiltration technology can be employed for the manufacture of low-lactose powder. Additional diafiltration treatment is employed to further reduce lactose. During the ultrafiltration process, some of the soluble salts like calcium, sodium and potassium are bound to go in the permeate. These salts are important for giving milk its natural taste. To maintain the salt level and thereby revive the original taste of milk on reconstitution, salts are added to the retentate before spray drying. Further, to improve the drying properties of the retentate and reconstitutability of the powder, 4% malto-dextrin is added to the retentate before spray drying.
2.3 MILK PROTEIN CONCENTRATES

Milk protein concentrates is a relatively new product based on ultrafiltration and drying of skim milk. Typically with a protein purity of 50-85%, milk protein concentrates can be considered as a functional ingredient to be used in the manufacture of other foodstuffs. To obtain milk protein concentrates with 85% protein/TS, it is necessary to employ diafiltration treatment. Dried milk protein concentrates can be used for the production of many dietetic foods.

2.4 NON DAIRY WHITENER

Non dairy whiteners are widely used as a substitute for fresh milk, cream or evaporated milk in coffee, tea, cocoa or drinking chocolate and are also suitable for adding to foods like soups, sauces, puddings and cereal dishes. Conventionally, sodium caseinate is mostly used as a protein source in the formulation of non dairy whiteners. The replacement of sodium caseinate, the conventionally used protein source in the non dairy whiteners by UF skim milk retentate has many advantages like reduction in product cost, process simplification and presence of nutritious whey proteins. The suitability of using UF skim milk retentate as a whitener is well established.

2.5 CHEESE POWDER

By means of ultrafiltration and drying, a milk powder can be produced for subsequent reconstitution and conversion into cheese. The main use is for export to those countries with low milk production and where the milk supply is very seasonal. The importing country then needs only to add water, starter and rennet to make cheese.

2.6 SEPARATION OF BIOLOGICAL PEPTIDES

Enzymatic modification of milk proteins permits development of peptides having unique physico-functional properties of pharmacological significance. Many of the nutritional and therapeutic attributes of cheese and fermented milk products have been attributed to the physiological role of bio-peptides derived from milk proteins. These bio peptides have been implicated in physiological roles such as biotransfer of trace elements, immunomodulation, antihypertension, antithrombosis, regulation of the gastrointestinal tract and the general behaviour (Morphine like activity). Membrane ultrafiltration is being used as the most appropriate tool for separating low molecular weight peptides and free amino-acids from proteins substrates utilizing enzymes.

2.7 VALUE ADDED PRODUCTS FROM WHEY

One dairy stream that is a potential raw material for the manufacture of value added products is whey. Ultrafiltration technology may be used to fractionate whey into components for use in value added products.

2.7.1 Whey proteins

Whey proteins have great potential in the areas of nutrition and physiological functionality. They are easily digested and are effective in meeting the body’s amino acid and energy requirements and are the most economical quality dietary protein source available. Human milk contains higher proportion of whey proteins than casein which markedly affect the curd tension of milk that aids to easy digestibility by infants. Whey proteins have been found to alter iron availability. Human studies show superior bioavailability of iron from human milk as compared to infant formula. This is presumably due to the presence of minor whey proteins and amino acids viz. cystein, taurine etc. which are present in higher concentration in human milk.
Whey proteins have been used as a fat replacer for a long time. The particles of coagulated protein can provide a fat-like mouthfeel and can effectively replace fat globules in certain foods. Aggregated proteins not only have the right particle size but are also hydrated. In this sense moisture replaces fat, and proteins facilitate the binding of this moisture in an appropriate manner. Whey proteins act effectively in oil-in-water emulsions such as an ice-cream mix. Whey protein based fat mimetics have recently been used in low fat variants of frozen desserts, yoghurt, fat spreads and cheese. These fat mimetics are made from concentrated cheese whey by special thermal and mechanical treatments which result in a controlled globular aggregation of denatured whey proteins termed as microparticulation. Suspensions of such microparticles, with diameters in the range of about 0.1 to 3 mm can produce a creamy texture similar to that of globular fat particles, like the milk fat globules. Limited information which is largely patented is, however, available on the processes used and leaves enough scope for further research on the particulation and structure formation of whey proteins under shear forces.

2.7.2 Lactose

Membrane technology offers distinct advantages over the conventional technology for the manufacture of lactose. The protein and mineral contents of whey are the limiting factors for the crystallisation of lactose and hence permeate obtained on ultrafiltration is considered as a better substrate for lactose production. Nanofiltration for concentration and simultaneous demineralisation and reverse osmosis for partial concentration of the permeate have also been suggested as intermediate processes in the manufacture of lactose.

2.7.3 Dicalcium phosphate

Whey minerals are the other whey constituents which can be recovered from the ultrafiltration permeates of acid whey. These melting salts of whey in the form of calcium-magnesium phosphate, can be used as food ingredient in meat and fish products.

2.7.4 Phospholipids

The phosphorous containing lipids are known to perform a wide range of biological functions and are of vital importance in human nutrition. They have been found to have anti-ulcer properties, work as antitumor promoters and aid in the cure of intestinal illnesses. Isolation and recovery of the phospholipid containing particulates from cheese whey and more importantly from buttermilk whey employing membrane processing is feasible.

2.7.5 Demineralised whey

The principal application of nanofiltration is for separation of mineral ions in the 10^-9 m size. The main emerging application of nanofiltration in the dairy industry is in partial demineralization of whey. Electrodialysis process is based on the removal of charged mineral ions from the non-charged material. This process has wide application in demineralization of whey for use in many special dietetic foods including infant formulae.

3.0 MICROFiltrATION PROCESS

Microfiltration processes are designed to separate particles in the so called micrometer range (0.1-10 micrometers). This process retains fat globules, microorganisms and somatic cells, but allows passage of proteins in addition to lactose and minerals.

3.1 SEPARATION OF NATIVE CASEIN

A promising application of microfiltration has been the selective separation of native casein micelles from the whey proteins. When whole or skim milk is circulated along a microfiltration membrane with a pore size of 0.1 mm, a microfiltrate with a composition close to that of sweet whey is obtained. The microfiltrate is crystal clear and can be sterile if
the downstream equipment prevents recontamination. The retentate is an enriched solution of native and micelle phosphocaseinate (PPCN). Diafiltration of PPCN can help in getting up to 90 per cent protein in dry matter and it is further concentrated by vacuum concentration and spray drying. The spray dried retentate can be used in applications where traditionally calcium caseinate has been used. Native casein has excellent rennet coagulating abilities and forms stronger gels at acidic pH.

3.2 PRODUCTION OF PASTEURIZED MILK WITH EXTENDED SHELF LIFE

Microfiltration process can be effectively employed for reducing the bacterial counts in skim milk by more than 99%. Subsequently treatment of skimmed milk and its re-add mixture with cream permits production of superior quality of pasteurized milk with extended shelf life. The process can also be used to remove spore forming bacteria from milk used in the manufacture of cheese, as high levels of spore formers (Clostridia etc.) can produce gas holes in cheese during ripening.

3.3 FRACTIONATION OF MILK PROTEINS

Application of membrane processing has opened up new possibilities for fractionation of milk proteins having unique functional characteristics. Theoretically, most milk proteins should be separable directly by selective membrane filtration of skim milk form the largest size to the least as follows: lipoproteins in milk fat globule membrane > casein micelles > immunoglobulins > lactoferrin > serum albumin > β-lactoglobulin > α-lactalbumin > casein-derived peptides.

Milk can be separated into its insoluble (caseins and fat) and soluble (whey protein, lactose, peptide and NPN) components. This separation is advantageous in the sense that the casein and fat fraction can be processed separately, avoiding the inevitable interaction between the casein and whey protein fractions under the influence of heat. This approach allows reconstitution of milk with “bio-protective factors” intact. Alternatively casein and fat rich retentate can be used for cheese production and the whey protein permeate can be ultrafiltered to obtain undenatured whey protein isolates of extremely high purity (pharmacological grade) displaying prophylactic quality. Various prophylactic biological preparations mentioned above have been tested under medical supervision to treat or prevent a range of human ailments such as arthritis, toothache, allergies, various kinds of viral infections such as common cold etc.
Since time immemorial, ghee has been used in Indian diet as the most important source of fat. Ghee, the Indian name for clarified butterfat is obtained by heat clarification and desiccation of sour cream, cream or butter. It is the largest indigenous milk product having an important place in Indian dietary, because of its characteristic flavor and pleasant aroma, besides being a source of fat-soluble vitamins.

In recent past, there has been great deal of questioning about the role of milk fat in the metabolism of cholesterol and other body functions. Ghee being a saturated fat and contains some cholesterol, is suspected to render the individuals prone to coronary heart disease (CHD). However, critical analysis of scientific literature shows no evidence of any association of milk fat with increased risk of CHD. On the other hand, in Ayurvedic system of medicine, ghee is considered to induce several beneficial effects to human health and is used extensively for therapeutic purposes, such as in the preparation of a number of formulations for treating skin allergy and respiratory diseases, and is considered capable of increasing mental powers and physical appearance, and curative of ulcers and eye-diseases. These practices suggest that ghee is a valuable form of dietary fat, but scientific validation of these claims is obscured. However, literature shows that milk fat contains several components (conjugated linoleic acid, sphingomyelins, butyric acid and β-carotene), which have therapeutic potential against carcinogenesis (Parodi, 1996). CLA, besides being a powerful anticarcinogen, has antiatherogenic, immunomodulating and lean body mass enhancing properties (Pariza, 1997).

Contrary to milk fat, vegetable oils despite of containing considerable amount of linoleic acid (known to promote carcinogenesis) have got the label of ‘health friendly oils’ because of literature showing hypocholesterolemic effect of polyunsaturated fatty acids (PUFA) and extrapolating it to decreased risk of CHD. Today, these vegetable oils have almost replaced dairy ghee from Indian kitchen. Diet dictocrats are promoting vegetable oils as if they are the complete solution for modern age deadly diseases, such as cancer and CHD. But actual situation is just the reverse. In spite of tremendous alterations in dietary fat patterns, mortality and morbidity due to these diseases is continuously increasing. In fact, inclusion of vegetable oil with a purpose to reduce serum cholesterol level has resulted in increased number of non-cardiovascular death especially cancer (Williams et al., 1981; McMichael et al., 1984; Delahaye et al., 1992; Tamakoshi et al., 1994). Further, excess consumption of oils rich in PUFA have been shown to contribute to a large number of diseases including heart disease, immune system dysfunction, damage to liver, reproductive organs and lungs, digestive disorders, depressed learning ability, impaired growth and weight gain (http://www.westonaprice.org/know_your_fats/know_your_fats.html).

Epidemiological studies supporting the vegetable oils and discrediting milk fat are subjected to potential biases due to several factors. Most importantly, total energy intake, which is a stronger predictor in the pathogenesis of cancer, is not generally taken into account. Even when total energy intake is controlled, it may be impossible to completely separate the effects of dairy intake from that of other dietary factors that alters cancer risk. Person with a high consumption of dairy product may also be likely to consume large amounts of meat or other fat foods that could also contribute to an increased risk of cancer. Further, other factors such as lifestyle, physical activity cannot be controlled in epidemiological studies. Besides this, various methods used in epidemiological studies, including food frequency questionnaires and diet records or food diaries, may not be reliable and some misclassification of intake is unavoidable.
Unlike epidemiological studies, almost every animal study conducted so far has witnessed protective role of milk fat against vegetable oil in carcinogen sis. Certainly, animal studies done under controlled conditions and taking particular item as variable keeping other items constant are the better alternatives to generate reliable information. Keeping in view of this we undertook studies to investigate the effects of dietary intervention of dairy ghee (cow and buffalo) vis-à-vis vegetable oil (soybean oil) on gastrointestinal and mammary carcinogenesis, arteriosclerosis and immunomodulation in rats (Bhatia, 2005).

**Gastrointestinal Carcinogenesis**

Intervention of dairy ghee (cow or buffalo) and soybean oil on gastrointestinal (GI) carcinogenesis was studied in 21 d old male albino rats fed for 33 wk. Carcinogenesis was induced by dimethylhydrazine dihydrochloride injected (IP) weekly for 20 wk starting fourth wk past start of the experiment.

- During post-injection period, the rats on cow ghee grew faster, and at the end of experiment weighed more than the rats on soybean oil or buffalo ghee.
- The incidence of tumors in GI tract was considerably higher in animals on soybean oil (73.30%) than on cow ghee (55%) or buffalo ghee (40%).
- Tumor multiplicity (tumor / tumor bearing rat) and tumor volume were less on ghee diets than on soybean oil (3.64; 677 mm³), and cow ghee was more effective (1.73; 59 mm³) than buffalo ghee (2.88; 472 mm³) in restricting these measures.
- The levels of thiobarbituric acid reactive substances (TARS), a measure of tissue lipid peroxidation, in liver and colorectal tissue on soybean oil were significantly greater than on ghee diets.
- Compared with soybean oil diet, CLA accumulation on ghee diets in colorectal tissue and liver was 5 and 7.5 fold, respectively.

**Mammary Carcinogenesis**

Intervention of dairy ghee on mammary carcinogenesis has been compared with that of soybean oil in 21 d old female albino rats fed for 42 wk. Tumors were induced by 7,12-dimethylbenz (a)anthracene (DMBA) administered (6 mg/animal) through oral intubations at 46 d of age.

- A large number of animals died in all dietary groups within 10 days due to acute DMBA toxicity. The mortality incidence was greater on soybean oil than in ghee groups. Thereafter, animals in ghee groups recovered and became healthy and survived till conclusions of experiment, but in soybean oil group, the condition of rats did not improve and mortality continued till termination of experiment due to neoplastic / non-neoplastic diseases.
- Animals on cow ghee, during post-induction period grew faster and weighed more than those on buffalo ghee or soybean oil. Cow ghee, therefore, attenuated growth inhibitory effect of DMBA.
- Tumor incidence did not vary among three dietary groups; however, tumor multiplicity was fewer on ghee. Tumor weight and tumor volume on cow ghee were not as much as on soybean oil or buffalo ghee. Thus, cow ghee opposed to buffalo ghee or soybean oil favorably intervened in promotional stage of carcinogenesis.
- Dairy ghee opposed to soybean oil diminished DMBA induced mortality and other neoplastic / non-neoplastic disorders.
• Accumulation of TARS in liver and mammary tissue of rats was significantly greater on soybean oil than on ghee diets. The difference was more conspicuous in target tissue (mammary tissue) than in liver.
• Compared to soybean oil, CLA accumulation in mammary tissue on cow and buffalo ghee was 12 and 9 fold, respectively.
• Significantly lower activity of superoxide dismutase (SOD) in liver was observed on soybean oil than on ghee diets.

**Lipid Profile, Immunomodulation and Antioxidative Status**

• Intervention of dairy ghee (cow or buffalo) and soybean oil on lipid profile, and antioxidative and immune status was studied in male albino rats (110 d old) fed hypercholesterolemic diet for 110 days.
• Mean body weights of animals on ghee diets (cow and buffalo) were significantly lower than on soybean oil, despite average feed intake was similar in three dietary groups.

**Lipid profile**

• Plasma total cholesterol level increased in all dietary groups (0-90 d period), however, mean cholesterol level during the entire study was significantly less on cow (71.3 mg/dl) and buffalo ghee (75.7 mg/dl) than on soybean oil (86.8 mg/dl).
• HDL-cholesterol also increased in all dietary groups (0-90 d). The rise in HDL-cholesterol level was highest on cow ghee (125%) and lowest on soybean oil (49%). Buffalo ghee registered 96 percent rise in HDL-cholesterol level.
• The increase in VLDL + LDL-cholesterol was inversely related to rise in HDL-cholesterol. The increase in VLDL + LDL-cholesterol on soybean oil was significantly greater than on ghee diets. Thus, the rise in plasma cholesterol on soybean oil was due, largely, to increase in VLDL + LDL-cholesterol (62%), whereas on ghee diets, HDL-cholesterol contributed to major part of rise (63-74%) in plasma cholesterol.
• Atherogenic index (VLDL + LDL-cholesterol / HDL-cholesterol) decreased significantly in ghee groups, but increased on soybean oil.
• Mean triglycerides level was significantly lower on cow ghee than on soybean oil and buffalo ghee.
• Deposition of cholesterol in liver was significantly less on ghee diets than on soybean oil. Cow ghee more efficaciously reduced the deposition of cholesterol and triglycerides in aorta compared with buffalo ghee and soybean oil.

**Antioxidative Status**

• Superoxide dismutase activity in RBC increased on all the three diets; the magnitude of increase was significantly greater on ghee diets than on soybean oil.
• Superoxide dismutase activity in liver and colorectal tissue was significantly higher in ghee groups opposed to soybean oil.
• There was no difference in the activity of glutathione-S-transferase in liver and colorectum between soybean oil and ghee groups.

**Immunomodulation**

• Activities of β-galactosidase and β-glucuronidase secreted by peritoneal macrophages were higher in ghee groups than in soybean oil group, and cow ghee oppose to buffalo ghee was more effective in augmenting these activities.
Percent phagocytosis (number of macrophages phagocytising foreign particle/100 macrophages) and phagocytic index (measure of foreign particles engulfed) were greater in ghee groups than on soybean oil.

CONCLUSIONS

1. Soybean oil containing polyunsaturated fatty acids promotes carcinogenesis, while dairy ghee, cow ghee in particular, attenuates the effect of carcinogen.
2. Compared with soybean oil, dairy ghee attenuates dietary hypercholesterolemia and decreases atherogenic index by way of increasing high-density lipoproteins. Cow ghee opposed to buffalo ghee is more effectual in improving lipid profile and that decreases deposition of cholesterol and triglycerides in aorta.
3. Dairy ghee opposed to soybean oil, improves immune system and antioxidative status, and cow ghee is more effectual than buffalo ghee. In addition, increased accumulation of CLA and decreased lipid peroxidation in tissues also correlate with its protective effects of dairy ghee.

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Role of Bacteriocins in Value Addition

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Food preservation is the method of preparing food so that it can be stored for future use. Because most foods remain edible for only a brief period of time, people since the earliest ages have experimented with methods for successful food preservation. As scientific investigations regarding the causes of food spoilage were undertaken, they pointed the ways to the wider application of methods already in use and to the discovery of new ones. Since the microorganisms are the main cause of food spoilage, food preservation depends on rendering conditions unfavorable for their growth. Processes of preservation may be generally classified as drying, heating, refrigeration, and the use of chemicals or other particular agencies.

Now, we have come a long way in the preservation of foods since the days of our hunter-gatherer ancestors. Health conscious consumers have started showing dissatisfaction with foods that are “harshly processed” and “chemically preserved.” Consumers are interested in having foods that are “natural” or “close to natural” and are minimally processed based on the perception that these are healthy, nutritious and free of chemical preservatives. The regulatory agencies and advisory groups have recognized the potential problems and advocated the use of “Natural preservatives.” The antimicrobial metabolites of food grade lactic acid bacteria are found to be effective in controlling the spoilage and pathogenic bacteria with minimally processed refrigerated foods and they are acceptable to both consumers and regulatory agencies.

Among the various antimicrobial metabolites produced by lactic acid bacteria like acetic acid, lactic acid, diacetyl, ethanol, hydrogen peroxide, bacteriocins have generated a considerable interest in recent years. Bacteriocins produced by the lactic acid bacteria appear to be very promising for use as biological food preservatives. All the bacteriocins from LAB fulfill the requirements of an ideal natural food preservative i.e. non toxic, stable during processing and storage, effective at low concentration, economically viable, non medicinal and pose no deleterious effect on the food.

Bacteriocins

Bacteriocins are ribosomally synthesized, extracellularly released bioactive peptides or peptides complexes which have a bactericidal or bacteriostatic effect on other (usually closely related) species (Tagg et al., 1976). Bacteriocins vary in spectrum of activity, mode of action, molecular weight, genetic origin and biochemical properties. Most of the bacteriocins from lactic acid bacteria are cationic, hydrophobic or amphiphilic molecules composed of 20 to 60 amino acid residues (Nes and Holo, 2000). The major classes of bacteriocins produced by LAB include: (I) lantibiotics, (II) small heat stable peptides, (III) large heat labile proteins, and (IV) complex proteins whose activity requires the association of carbohydrate or lipid moieties (Klaenhammer, 1993).

The inhibitory spectrum of bacteriocins is restricted to Gram-positive bacteria mainly, but several bacteriocins produced by lactic acid bacteria are active against food spoilage and food-borne pathogenic microorganisms. Furthermore, many bacteriocins are heat-stable, making them applicable in heat treatment. They appear to have a universal bactericidal and irreversible mode of action and they are food stable, biodegradable, digestible, safe to health and active at low concentrations.
Bacteriocins in Biopreservation

Biopreservation refers to extended shelf life and enhanced safety of foods using the natural microflora and (or) their antibacterial products. Lactic acid bacteria have a major potential for use in biopreservation because they are safe to consume and during storage they naturally dominate the microflora of many foods. Bacteriocins are produced by strains of Lactococcus, Lactobacillus, Pediococcus, Leuconostoc, Carnobacterium, Streptococcus, Enterococcus, and Bifidobacterium.

As bacteriocins produced by LAB are having antibacterial activity against a number of food spoilage and pathogenic bacteria viz. Bacillus cereus, Clostridium botulinum, Clostridium perfringens, Listeria monocytogenes, Staphylococcus aureus, etc., they have been the subjects of intensive scientific scrutiny during the past 20 years, leading to detailed characterization of a wide range of these natural inhibitors. Nisin, the bacteriocin produced by Lactococcus lactis subsp. lactis, has been granted GRAS (Generally Recognized as Safe) status by Food and Drug Administration (1988) and is widely used as biopreservative in more than 48 countries in a number of food products, e.g., semihard & hard cheeses (prevents late blooming), processed cheese, cheese spread (to inhibit C. butyricum, C. tyrobutyricum), sterilized milk (to inhibit thermophilic heat resistant spore formers), milk powder, canned foods, low acid foods, meat products etc. (Laukova et al., 1999; Pawar et al., 2000). More recent applications of nisin include its use as a preservative in high moisture, hot baked flour products (crumpets) and pasteurized liquid. Considerable research has been carried out on the anti-listerial properties of nisin in foods and a number of applications have been proposed. Uses of nisin to control spoilage lactic acid bacteria have been identified in beer, wine, alcohol production and low pH foods such as salad dressings. Further developments of nisin are likely to include synergistic action of nisin with chelators and other bacteriocins, and its use as an adjunct in novel food processing technology such as higher pressure sterilization and electroporation.

Use of Pediocin PA-1 produced by Pediococcus acidilactici in cottage cheese, half and half cream and cheese sauce systems has been found to be effective in controlling the growth of Listeria monocytogenes. Enterocins the bacteriocins from enterococci have shown a potential for dairy applications as biopreservatives as these are insensitive to rennet and heat and have stability over a wide range of pH. Several other bacteriocins like that from Streptococcus thermophilus, an important culture for yoghurt production, and Propionibacteria have been reported to produce bacteriocin which have the potential to be used in food preservation.

Nitrates are commonly used to preserve meats. However, safety concerns regarding the presence of nitrites in foods have prompted the researchers to explore alternative methods of preservation. Nisin or its combination with lower levels of nitrate could prevent the growth of Clostridium, but because of high pH of meat products, and inability of nisin to uniformly distribute itself in meat, application of several other bacteriocins was explored. Leucocin A, enterocins, sakacins, pediocins and the carnobacteriocins A and B prolong the shelf life of meat products (Cleveland et al., 2001).

Bacteriocinogenic Starters/ Protective Cultures

Bio-protective cultures may act as starter cultures in the food fermentation process or they may protect foods without any detrimental organoleptic changes. Since lactic acid bacteria are commonly used as starter cultures in food fermentations, investigators have explored the use of bacteriocin producers as starter cultures. In some cases, natural bacteriocin producers, such as Lactobacillus plantarum, Pediococcus acidilactici and Enterococcus faecalis, Enterococcus faecium have been used as protective cultures in various products. For instance, bacteriocin producing E. faecalis strain reduced the growth of L. monocytogenes by 6 logs in cheese manufacture (Nunez et al., 1997).
In dairy practice, nitrate is commonly added to cheese milk to prevent outgrowth of clostridia spores. Outgrowth of these spores was completely prevented when a nisin A producing stain was mixed at 10% rate with the starter culture (Wessels et al., 1998). *Bacillus cereus*, a food poisoning bacterium, had been found to be inhibited by the bacteriocinogenic strain of *Enterococcus faecalis* A-48-32 in milk and in a nonfat hard cow’s cheese (Munoz et al., 2004).

In dry sausages and certain meat products, the utilization of bacteriocin producing *P. acidilactici* and *L. plantarum* and, *E. faecium* as fermenting agents help to reduce the number of *Listeria monocytogenes* (Dicks et al., 2004). In contrast to Gram-positive bacteria, Gram-negative such as *E. coli* O157:H7 possesses in addition to an inner membrane, an outer membrane through which the hydrophobic bacteriocins are not able to permeate. The use of some food grade permeabilizers like citric acid or lactic acid, in combination with bacteriocins would be effective in inhibiting Gram-negative bacteria in foods (Helander and Mattila-Sandholm, 2000).

The application of bacteriocin producers as protective cultures present the problem of inhibition of desired LAB used for fermentation. Alternative approach to overcome such a problem is to use bacteriocin producing strains with a highly specific activity towards pathogens only e.g. Bacteriocin from *E. faecium* DPC 1146, 7C5, RZS, C5 is extremely active against *L. monocytogenes* but had no effect on the starters (Parente and Hill, 1992; Yamamoto et al., 2003).

Another approach is the use of transformants e.g. *Pediococcus* spp. do not have the application as cheese starters, so the transfer of plasmid encoding pediocin in *Lc. Lactis* aid in the preservation of cheddar cheese. Pediocin PA-1 expressed in the yeast *Saccharomyces cerevisiae* help to improve preservation of wine, bread etc. Besides these conventional methods the use of molecular biology methods for the heterologous expression of bacteriocin encoding genes and construction of multiple bacteriocins producing LAB for effective biopreservation is on the way.

**Bacteriocin Production: An Important Criterion for Probiotic Selection**

In recent years there has been renewed interest in health promotion and disease prevention by incorporation of probiotic bacteria into foods to counteract harmful bacteria in the intestinal tract. There is considerable interest in extending the range of foods by incorporating foods containing probiotic organisms from dairy foods to infant formulas, baby foods, fruit juice-based products, cereal based products and pharmaceuticals. Probiotic bacteria are commonly defined as viable bacteria, in single or mixed culture, that have a beneficial effect on the health of the host. In dairy industry the most widely used probiotic bacteria belong to the group of lactic acid bacteria (LAB), though some Bifidobacteria and yeast are also utilized. Health benefits by probiotic organisms include prevention or alleviation of diarrhea, antimicrobial, antmutagenic and anticarcinogenic properties, reduction of serum cholesterol levels, and improvement of lactose tolerance (Shah, 2000).

Klaenhammer and Kullen (1999) had compiled selection criteria for probiotic strains. These include: (1) appropriateness (accurate taxonomic identification, normal inhabitant of the host species targeted, i.e. nonpathogenic, nontoxic, human origin, GRAS status), (2) technological suitability (amenable to mass production and storage, concentration, freezing, stability of desired characteristics etc.), (3) survival competitiveness and establishment (capable of survival in harsh environment of GIT, proliferation, and adherence and colonization potential), (4) performance and functionality (able to exert one or more health benefits, antagonism towards pathogens, production of antimicrobial substances such as bacteriocins, immunostimulatory, antmutagenic, anticarcinogenic activity).
Bacteriocin production is considered as one of the performance or functional characteristics of probiotic strains as it helps to establish the probiotic organism in competitive environment of gut. Intestinal LAB are known to produce bacteriocins which can inhibit pathogenic bacteria, for example, *L. acidophilus* LF221, isolated from infant faeces was shown to produce at least two bacteriocins (acidocin LF221 A and acidocin LF221 B) which exhibited activity towards different bacteria including some pathogenic species such as *Bacillus cereus*, *Clostridium difficile*, *Listeria innocua*, *Staphylococcus aureus* and group D streptococci (Bogovic-Matijasic et al., 1998). Moreover, Audisio et al (2000) showed that *Enterococcus faecium* J96, isolated from a healthy free range chicken, exhibited a protective effect on chicks infected with *Salmonella pullorum*. The effect of bacteriocin producing *Lactobacillus sakei* MI401 against *Listeria monocytogenes* EP2 in the intestinal tract was examined in vivo and found that number of *L. monocytogenes* decreased significantly in group which received *L. sake* (Sadbye et al., 1999). Recently, the one of the most efficiently used commercial probiotic strain of *E. faecium* SF68, which has a long history of safe use, had been shown to produce the bacteriocin (Moreno et al., 2003). Directly or indirectly, bacteriocins have an important role in the probiotic properties of an organism.

**Conclusions**

The effectiveness of bacteriocins as food preservative is well documented. Though nisin is the only purified bacteriocin used commercially, others, such as pediocin, enterocin, thermophilin etc. have application in food systems. The application of bacteriocins from lactic acid bacteria in combination with the traditional methods of preservation and proper, hygienic processing could be effective in controlling spoilage and pathogenic bacteria, particularly human pathogens such as *L. monocytogenes*, Clostridia, *Bacillus spp.* and *Staphylococcus aureus*. Well characterized, homofermentative, mild acidifying bacteriocinogenic LAB are ideal candidates for biopreservation and to act as protective cultures for various foods. Besides this, bacteriocin production gives the probiotic organism an added advantage to establish itself in the gut.

**References**


Bio-imaging and Sensing Applications in Dairy and Food Industries

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Introduction

Inspection of food quality by digital image sensing is gaining importance in modern high-volume, fully-automatic food processing plants. It offers the advantage of rapid, accurate and non-destructive quantification of various quality characteristics of food products. The images of biological products, such as food and agricultural products can be acquired in visible or non-visible range of electromagnetic waves. A vision based sensing system consists of a source of illumination or radiation, and a spatial sensor, which measures the distribution of reflected or absorbed radiation at each point of an object. The signal generated by a spatial sensor is a 2-D image data, which needs to be correlated with the characteristics of the products under inspection. Thus, a computer is an integral part of an image based sensing and inspection system. Computer softwares are used for data acquisition, processing, analysis and interpretation. Rapid decisions regarding acceptance, rejection or recycling can be made by the image based sensing and control systems. Thus, for online quality inspection of food product, computer integrated imaging systems are indispensable tools for modern automatic food processing industry.

Visible imaging

A simple machine vision system uses charge couple devices that are sensitive to the visible light in the electromagnetic spectrum. The visible cameras are of color or monochrome types to determine the reflectance characteristics illuminated by a light source. The steps involved in visible image based quality sensing are presented in the following section.

Image acquisition

A laboratory visible imaging system, also known as computer vision system, consists of a sensor or camera to acquire two or three dimensional images of products, which are converted into digital images by a digitizer and stored in the computer digital images (Fig. 1). The digital images are processed using computer algorithms to recognize the product and to determine its characteristics. Based on the characteristics determined, products can be classified or inspected for rejection. Thus an online machine vision inspection system consists of image acquisition, digitization, processing, classification and actualization. Vision systems are affected by the level and quality of illumination. A well designed illumination system can
help to improve the success of the image analysis by improving image contrast. Good lighting can reduce reflection, shadow and some noise giving decreased processing time. Various aspect of illumination including, location, lamp type and color quality need to be considered when designing an illumination system for application in food industry (Panigrahi and Gunasekaran, 2001).

**Image processing and Analysis**

Image processing involves a series of image operations that enhance the quality of an image in order to remove defects such as geometric distortion, improper focus etc. Image analysis is the process of distinguishing the objects (regions of interest) from the background and producing quantitative information, which is used in the subsequent control systems for decision making. Image processing/analysis involve a series of steps, which can be broadly divided into three levels: low, intermediate, and high, as shown in figure 2.

Low level processing includes image acquisition and pre-processing. Digital image acquisition is the transfer of electronic signal from the sensing device (camera) to the computer in digital form. A digital image is represented by a matrix of numerical values, each representing a quantized image intensity value. Each matrix element is known as pixel (picture element). The total number of pixels in an image is determined by the size of the 2-D array used in the camera. The intensity of the monochrome image is known as the grey level. When an 8-bit integer is used to store each pixel value, gray levels range from 0 to 255, where 0 is black and 255 is white. All intermediate values are shades of gray varying from black to white. Each pixel in color image is represented by 3 digits representing RGB (Red, Green, Blue) components with each digit varying from 0 to 255. The RGB values can also be converted to HSI (Hue, Saturation and Intensity) color model for further processing.

Preprocessing of raw data involves improving image quality by suppressing undesirable distortions or by enhancing important features of interest.

Intermediate level processing involves image segmentation, and image representation and description. Image segmentation is the operation of selecting a region of interest that has strong correlation with objects. It is therefore one of the most important steps in the entire image processing technique, as subsequent extracted data are highly dependent on the accuracy of this operation. Segmentation can be achieved by three different techniques: thresholding, edge-based segmentation and region based segmentation. Thresholding is a simple and fast technique for characterizing image regions based on constant reflectivity of their surfaces. Edge-based segmentation relies on edge detection by edge operators. Edge operators detect discontinuities in grey level, color, texture, etc. Region segmentation involves the grouping together of similar pixels to form regions representing single objects within the image. The segmented image may be represented as a boundary or a region. Boundary representation is suitable for analysis of size and shape features while region representation is used in the evaluation of image texture and defects.

Image description deals with the extraction of quantitative information from the previously segmented image regions. Various algorithms are used for this purpose with morphological, textural, and photometric features quantified so that subsequent object recognition and classification may be performed.

Image morphology refers to the geometric structure within an image, which includes size, shape, particle distribution, and texture characteristics. Texture is characterized by the spatial distribution of gray levels in a neighborhood. For most image processing purposes, texture is defined as a repeating patterns of local variations in image intensity, which are too fine to be distinguished as separate objects at the observed resolution. Image texture can be used to describe such image properties as smoothness, coarseness and regularity.
High level processing involves recognition and interpretation, typically using statistical classifiers or multilayer neural networks of the region of interest. These steps provide the information necessary for the process control for quality sorting and grading.

At each stage of image processing process, interaction with a knowledge database is essential for more precise decision making. Algorithms such as neural networks, fuzzy logic and genetic algorithms are some of the techniques of building knowledge base into computer structures. Such algorithms involve image understanding and decision making capacities thus providing system control capabilities.

**Applications of visible imaging**

With the decreasing price of hardware and software, computer vision systems are being increasingly used for automated quality inspection systems. It has been successfully implemented for objective, online measurement of quality of several food products, such as, horticultural produce, meat and fish, dairy and bakery, and food grains.

**Dairy and Bakery**

Internal and external appearances of baked products are important quality attribute, generally correlated with the overall consumer acceptability of the product. Scott (1994) described a system which measured the defects in baked loaves of bread by measuring its height and slopes of the top. The internal structure of bread and cake, such as cell size, density, cell distribution were analyzed and were directly correlated with the texture (Sapirstein, 1995). More recently, the consumer acceptability of chocolate chip cookies were correlated with the size, shape and percentage chocolate on the top surface of cookies (Davidson et al., 2001).

Functional properties of cheese were evaluated by Wang and Sun, 2002. Meltability and browning properties of cheddar and mozzarella cheese were evaluated under different cooking conditions and size of samples using machine vision. Ni and Gunasekaran (1995) developed algorithms for evaluation of cheese shred dimensions using machine vision. This will help maintain the quality of cheese shreds to be used in pizza toppings.

**Meat, fish and poultry**

Visual inspection is used extensively for the quality assessment of meat products applied to processes from the initial grading to consumer purchases. McDonald and Chen (1990) investigated image based beef grading. They discriminated between fat and lean in I.d. muscle
based on reflectance characteristics, however poor results were reported. Recently, Subbiah (2004) examined computer vision for predicting the tenderness of aged, cooked-beef. Textural features extracted from images of fresh beef using statistical methods, Gabor filters, and wavelets were used to predict tenderness. The adaptive segmentation algorithm for color beef images separated l.d. muscle with 98% accuracy. A linear regression model using statistical textural features predicted shear force tenderness with an $R^2$ value of 0.72. A canonical discriminant model using Gabor textural features classified carcasses into three tenderness groups with 79% accuracy. A stepwise regression model using wavelet textural features successfully classified carcasses into nine tenderness certification levels. Poultry carcasses were characterized using multispectral imaging techniques. The multispectral images of chicken carcasses were able to detect and separate bruise, tumors, and skin torn carcasses from normal carcasses (Park et al., 1996). Artificial neural network (ANN) models were employed for image feature extraction and classification. The ANN models performed with 91% accuracy in classification of carcasses. Automatic fish sorting techniques using image analysis has been investigated to reduce tedious human inspection and costs (Strachan and Kell, 1995). Using this technique, fish species were identified and sorted online from a conveyor belt.

Fruits and vegetables

Computer vision has been extensively used for classification, defect detection, quality grading and variety classification of fruits and vegetables. Defect segmentation on Golden Delicious apples was performed by color machine vision system (Leemans et al, 1998). The developed algorithm for color images gave satisfactory results with well contrasted defects. Tao and Wen (1999) developed a novel adaptive spherical transform for machine vision defect sorting system. The transform used fast feature extraction and improved the speed of inspection up to 3000 apples/min. The system had an accuracy of 94% while sorting defective apples from good ones. Machine vision based sorting systems for peaches, strawberries, tomato and oranges, and mushrooms have been developed for sorting based on shape, size and color features of fruits and vegetables (Tao et al., 1995). Sugar content, acidity and other physico-chemical parameters of fruits and vegetables were predicted from the visible and nonvisible images of fruits and vegetables (Kondo et al., 2000, Steinmetz et al., 1999).

Non visible Imaging of Agricultural and Food Materials

Images of biological products can be obtained by the radiation energy, which are non visible to human eyes. Such imaging techniques are NIR, X-ray, MRI and IR energy sources. Fig.4 shows the images of apples obtained by several imaging techniques. The nonvisible imaging techniques and their applications ave been discussed in the following sections.
X-ray imaging

Electromagnetic waves with wavelengths ranging from 1 to 100 nm are called soft X-rays. The less penetrative power and ability to reveal the internal density changes make soft X-rays suitable for agricultural and food products. The X-ray systems are mainly used for inspection purposes to detect product density, maturity, internal defects, damages, infestations, and presence of contaminants or foreign materials.

X-ray provides a cross-sectional view of an object’s interior. A typical X-ray imaging system consists of an x-ray source, a detector array, and mechanical system to move materials through the source and detector. When x-ray passes through a material, they are partly absorbed along the way by the test specimen. The intensity is reduced according to an absorption coefficient, which depends on the elemental component and its density. The x-ray absorption coefficients for the food materials depend on the energy level of the x-rays. X-rays with energy levels in the 5-15 kV range are much more easily absorbed than 120 kV or higher range.

Kotwaliwale (2003) developed x-ray imaging system for inspection of pecan nuts. Equipment was developed for high-resolution (1024 x 1024 pixels) digital X-ray imaging of pecans with soft X-rays (less than 50 kVp). Nutmeat quality features were determined from pecan X-ray images taken at six X-ray energy levels. The linear attenuation coefficient of pecan shell was higher than that of nutmeat. Defects and insects were clearly differentiated in X-ray images after applying contrast stretching or high-frequency emphasis (Fig. 5).

X-ray energy used to generate radiographs for other products has been reported as 25 kVp for 90 s for pistachio nuts (Keagy et al., 1996), 50 kVp and 10-13 mA for apples (Kim & Schatzki, 2000), 30 33 KeV and 16 mA for meat (Tao & Ibarra, 2000), 32 kVp and 3 mA for 60 s on films and 35 keV and 30 mA for 3 ms on X-ray line scan for almonds (Kim and Schatzki, 2001), 15 kVp and 65 µA for 3-5 s for wheat (Karunakaran et al., 2002). Haff and Slaughter (2002) while using X-rays at 12 keV and 99 mA observed higher contrast wheat images and commented that the large current reduced the quantum noise.

Fig 4: Apples images from different imaging techniques: (a) visible, (b) x-ray (c) MRI, (d) NIR and (e) IR (thermograph). (Jayas and Karunaaran, 2005).
Magnetic Resonance Imaging

MRI images are obtained by mapping the resonance absorption of magnetic energy by certain nuclei, which are subjected to magnetic energy by a rotating magnetic field or pulse radiofrequency. The amount of energy absorbed by the nuclei is directly proportional to the number of nuclei present in the sample. Therefore it is possible to measure the moisture and fat contents of a food product by measuring its proton signal intensity. MRI is capable of producing 2-D or 3-D images by line area and volume scans of products. In food industry, MRI has been used for obtaining distribution of moisture and fat in food products (Rosen et al, 1984). MR has been used to evaluate internal quality features of fruits and vegetables. These factors include maturity, bruise, dry region, worm damage, and presence of voids and seeds. Wang et al. (1988) used MRI to obtain images of water core and its distribution in red delicious apples. Ishida et al. (1989) were able to distinguish the physiological variation among different types of tissues and physiological changes during maturation of tomato. Recently the method has been explored to determine the volume of single berries and Brix distribution in a grape bunch and internal characteristics such as firmness, total soluble solids, sugar content, and titrable acidity of apples (Andaur et al, 2004; Letal et al., 2003).

NIR Imaging

NIR images can be very valuable for food quality evaluation. For imaging purposes, the NIR waveband can be divided into two groups: 700-1100 nm and >1100 nm. NIR images based on 700-1100 nm can be used for detecting defects and for mapping moisture and protein in food products (Panigrahi and Gunasekaran, 2001). Although NIR spectroscopic techniques have been used for quality evaluation of food products, NIR imaging could provide additional spatial information that is not available from traditional spectroscopic techniques. For example, NIR spectroscopy can be used to measure the overall protein, oil or moisture content, whereas NIR images will show the distribution of such components within the food material. Therefore NIR imaging may replace NIR spectroscopy for some applications.

Infrared or thermal imaging

Thermal images can be obtained by IR cameras which are sensitive to the thermal infrared band (3 – 5 mm). IR cameras can also measure temperatures from -10 to 1500°C. Thus
infrared imaging can be used for characterizing thermal properties and moisture related studies. IR imaging was used to estimate the internal temperature of chicken meat after cooking (Ibarra et al., 1999). The thermal conductivity or diffusivity of products with different characteristics emit different radiations and can be used to differentiate them. The use of IR imaging is gaining momentum in the food industry (Jayas and Karunakaran, 2005).

**Conclusions**

Review of different image based sensing techniques and their applications shows that there is a great potential of these nondestructive quality evaluation tools in food industry. The automated, objective, rapid and hygienic inspection of raw and processed foods can be achieved by computer vision systems. Visible or non-visible image based computer vision has the potential to become a vital component of automated food processing operations as increased computer capabilities and greater processing speed of algorithms are continually developing to meet the requirements of online quality control systems.

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Milk is Marvellous

There is no denying the fact that milk in human diet is unsurpassed by any other food. Its nutritional virtues are remarkable by any standards. It is rightly considered to be a ‘nearly complete food’. However, with rapidly changing lifestyle in opulent countries as also in most of the urban and even certain prosperous rural areas of countries like India, the diet has become much of a concern for health. In this regard, the sedentary ways of life has greatly contributed to the association of heart and other related ailments with saturated fat and cholesterol in the diet. Obviously, therefore, milk and milk products come under the cloud on account of this suspected role in coronary heart disease.

Another, diet and health related issue is the ‘low-residue’ nature of milk and most dairy products attributable to the absence of dietary fiber in them. This attribute of milk becomes particularly relevant when the overall diet does not contain adequate amounts of dietary fiber as, again, is the case in much of the wealthy populations. In this context, then, milk and milk products considered as a vehicle for dietary fiber would not only take care of their own role in human health but could also enhance the healthfulness of the diet as a whole. Incorporation of dietary fiber in milk could do much to negate the adverse publicity that is often given to this otherwise ‘benign’ commodity. The health-promoting attributes of dietary fiber and possibilities of enriching milk and milk products with it are discussed in the following paragraphs.

What is Dietary Fiber?

More than three decades back when the significance of dietary fiber was first realized, it was defined as “the remnants of edible plant cells including polysaccharides, lignin, and associated substances that are resistant to digestion in the alimentary tract of humans”. It was thus referred to as a macro-constituent of foods, which includes cellulose, hemicellulose, lignin, gums, modified cellulose, mucilages, oligosaccharides, and pectin and associated minor substances such as waxes, cutin and suberin. Later, the definition was widened to include all indigestible polysaccharides. Thus, the AACC (American Association of Cereal Chemists) definition came to be widely accepted which defines “dietary fiber is the remnants of the edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine. It includes polysaccharides, oligosaccharides, lignin, and associated plant substances. Dietary fiber exhibits one or more of laxation (fecal bulking and softening: increased frequency and/or regularity), blood cholesterol attenuation, and blood glucose attenuation.” The term ‘analogous carbohydrates’ mentioned here is defined as those materials, not necessarily intrinsic to a part of a plant as consumed, that exhibit the digestion and fermentation properties of fiber. These are produced during food processing, by chemical and/or physical processes affecting the digestibility of starches, or by purposeful synthesis. Oligosaccharides include fructan, neosugar, raffinose, stachyose, 4’-galactosyl-lactose, 6’-galactosyl-lactose, xylo-oligosaccharide, maltitol, lactitol, palatinit, lactulose, oligofructose and inulin while associated plant substances include phytate, lectins, non-polymeric polyphenols. The desirable daily intake of dietary fiber is 25g for persons consuming 2,000 cal daily and 30g per day for those consuming 2,500 cal. WHO recommends 16-24g/day of
non-starch polysaccharides or 27-40g/day of total dietary fiber. National Institute of Nutrition (NIN), Hyderabad recommends an intake of 25-40g total dietary fiber per day or 12-14g total dietary fiber per 1000 kcal per day.

**How is Dietary Fiber Beneficial in Human Health?**

In 1970, Burkitt, Painter and Trowell of the USA observed that the rural Africans with their fiber-rich diet did not have many of the diseases that plagued the west where the fiber in diet was much less. They theorized that the high fiber diet not only exerted positive effects on the gut directly but had many other systemic effects as well. Thus, fiber was launched from merely being ‘roughage’ to a substance with many possible therapeutic and preventive roles in human health. Inadequate intake of dietary fiber can increase the risk of constipation, bowel irregularities, hemorrhoids (a disease characterized by swollen veins in the wall of the anus), and diverticulosis (disease causing small pockets or out-pouchings to occur in the bowel). Lack of sufficient dietary fiber can lead to numerous negative consequences in overall body health. Lack of fiber in the diet has been found to relate to the occurrence of such common disorders as ischemic heart disease (deficiency of blood supply to the heart), appendicitis, gall bladder disease, varicose veins (permanently and abnormally dilated veins), deep vein thrombosis (coagulation of the blood in a blood-vessel), hiatus hernia (a state of protrusion of part of an organ through the wall of the body cavity containing it), and tumors of the large bowel (or colorectal cancer). Inclusion of fiber in the diet has been associated with decreased bowel transit times, increased stool weight and reduced serum cholesterol.

The physiological attributes of dietary fiber depends on their physical characteristics namely the molecular design and solubility in water to form a gel of high viscosity. Dietary fibers, both soluble and insoluble, have b 1-4 covalent bonds. The human digestive enzymes cannot cleave b linkages and only can cleave the a linkages. The physiological role of dietary fiber is that it adds to the bulk of the diet helping in easy transit of the food in the gastrointestinal tract. Reduced transit time promotes regularity and minimizes risk of colon cancer by decreasing the time that colonocytes are exposed to potentially carcinogenic wastes. It holds water and in turn, softens the stools for easy excretion. The protective effect of dietary fiber against cancer was attributed to, the diluting effect of bulky stools (from a high-fiber diet) on concentration of carcinogenic waste products in the tract derived from the diet or formed by bacterial metabolism from unabsorbed dietary components such as bile acids, and to the reduced contact time with the intestinal mucosa owing to more rapid stool transit.

**Fiber-Rich Foods**

High-fiber foods include fruits, vegetables, whole grains, and legumes. These provide pectin, hemicellulose, cellulose and lignin. Pectin and hemicellulose are generally considered soluble fiber, have higher water-holding capacity, form gels in the intestines, and are in higher quantities in fruits, vegetables and legumes. Insoluble fibers, cellulose and lignin, are not water-soluble, have a lower water-holding capacity and are derived from the tougher structural components of plants. The dietary fiber content of fruits and vegetables ranges from 0.5g/100g for fresh watermelon to 10.3g/100g for fresh passion fruit and 10.9g/100g for sapota (chiku). Fruits like dates, prunes, raspberries, guavas, gooseberries, cranberries and raisins are moderately rich in dietary fiber while among vegetables, brinjal, amaranth, bittergourd and broccoli are good sources of dietary fiber. Among legumes, soybeans and green peas are quite rich in dietary fiber. Although root crops have generally been branded as ‘poor man’s crops’ supplying low cost energy and bulk to the diet, their potential as nutritionally rich sources of beta-carotene, anti-oxidants, dietary fiber and minerals like calcium has begun to be recognized worldwide. Sweet potatoes and yams are moderately rich in dietary fiber.
Dried fruits, nuts and seeds are rich in dietary fiber, especially poppy seeds, mustard seeds, flax seeds and sunflower seeds among seeds; and almonds, chestnuts, pistachio nuts and coconut among dried fruits and nuts. Out of the total dietary fiber content, insoluble fiber is far more than the soluble fiber. Cereals as whole grains or their brans as a separate entity are rich in dietary fiber. Food gums, the concentrated source of dietary fiber, are the complex polysaccharides, containing several different sugar molecules and uronic acid groups. Gum acacia, gum tragacanth, gum karaya and gum ghatti are the exudates of various plants obtained when the bark is cut or the plant is otherwise injured. While guar gum and carob (locust) bean gum are examples of gums derived from seeds, gum xanthan is produced by the microorganism *Xanthomonas campestris*.

**Fiber in Dairy Foods**

While most dairy products do not contain dietary fiber, there are a few dairy foods, which contain certain non-dairy ingredients contributing varying amounts of fiber. Fruit – containing products such as yoghurt, ice cream, custard, etc. are well-known examples of such foods. Also, dietary fiber can be incorporated into the diet as purified fiber or in the form of a fiber-rich source. Purified dietary fiber may be in the form of pure cellulose, hemicellulose, xylan, raffinose, pectin, guar gum, sodium alginate, carrageenan, carob bean gum, ispaghula husk, inulin, resistant starch, or their mixtures, while fiber rich sources may include wheat bran, corn bran, oat bran, sorghum meal, barley hulls, barley husk, soyabean hulls, lipin hulls, pea hulls, canola hulls, fruits and vegetables. There are several international companies which manufacture and supply dietary fiber preparations e.g., Pro-fibre Nutrition (U.K.) manufactures Fibre-Hi, Golden Jersey Products Inc. (U.S.A.) supplies Oatrim, Nutrasweet Kelco Co., (California) offers Primacel, Benelux Firm Benuline, (Netherlands) has Fibruline-R, Grindsted products (Denmark) manufactures carrageenan, while Meer Corporation of New Zealand sells Merecol. Cellulose and marine colloids are manufactured by FMC Corporation, Philadelphia. Also, ID Foods (France) manufactures Soluline IDA and ID Tex, while Crispy Food International (Denmark) supplies a Fiber topping. In India, soluble fiber inulin is available from S.A. Pharmachem, Mumbai, Polydextrose is supplied by Danisco, whereas wheat, oat-, and several other fiber preparations are offered by Clarico-FPC, Mumbai.

**Fiber - rich Ingredients in Dairy Foods**

Added vegetables can add variety as well as dietary fiber to the dairy products. Sweet potato yoghurt and yam yoghurt have recently been reported as novel health-providing dairy foods. In India, people are familiar with various regional traditional dairy products, which contain added vegetables. Various non-dairy ingredients including vegetables such as boiled and dried potatoes, raw onion pieces, raw cucumber, tomatoes, carrot, pumpkin, ginger, grated coconut and roasted cumin seeds or fried mustard seeds, banana or mango pieces, fried besan (bengal gram flour) or moong dal flour granules or fried lady finger have been reported to be added to well beaten and spiced dahi, commonly known as raita. Kadhi is another prominent Indian culinary item, which contains non-dairy ingredients such as bengal gram flour (besan) stirred into dahi or buttermilk in addition to boiled vegetables, salted and sautéed onions and sometimes also fried-balls of spiced besan batter (pakora). Carrot-based Gajar-ka-halwa, Lauki kheer (Bottlegourd kheer) or Doodhi Halwa, are among other Indian dairy delicacies which contain dietary fiber. Fruit and nut ice cream, which may contain strawberry, apricot, pineapple, mango, banana etc. and/or nuts such as almonds, pistachio, walnuts and cashewnuts are valued for their palatability. Fruits are also reported to reduce the harsh acidity and off-flavours, if any, present in yoghurt. They can be added to yoghurt either before yoghurt setting (fruit-on-bottom yoghurt) or to stirred yoghurt (bulk-mixed fruit yoghurt). In a recent study, yoghurt with raisins, peanuts and coconuts was liked very
much' by 90% of old respondents and 87% of adults, but 90% of adults showed such high preference for yoghurt with only raisins and peanuts. Eighty-two per cent of adults liked strawberry yoghurt ‘very much’. These acceptability ratings were considerably higher than those for yoghurt containing vegetables such as cucumber and celery. These results showed that vegetable yoghurt was less acceptable than the fruit yoghurt. Several varieties of Shrikhand, a popular sweetish-sour fermented milk product of Gujarat and Maharashtra, are reported to be prepared by adding pulp of certain fruits such as mango, banana, papaya and nuts to chakka. Burfi is another popular traditional milk sweet prepared with cashewnut (known as kaju - katri / katli), almond, pistachio, coconut, etc.

The chemical structure and the physico-chemical properties are both thought to determine the functional properties of dietary fiber. Starch as a complex carbohydrate is a good source of dietary fiber depending on processing and storage. Indigestible dextrin, prepared by heat treatment of corn starch has found suitable for incorporation into products like milk shakes, ice creams, yoghurt, dried cheese and cream cheese to serve as dietary fiber in the products. A frozen breakfast food containing fluid milk infused into grains such as rice, wheat, oats or mixtures of the three has been developed by Healthy Grain Foods (USA).

Several traditional Indian dairy products contain various cereal and legume as ingredients. Kheer and Payasam are prepared using rice, sevian (vermicelli), makhan (lotus puffs), sago (tapioca starch) and nuts (almonds, pistachio and cashews). Payasam may also contain vermicelli, kaddu (pumpkin), poppy seeds (khus-khus), bengal gram dal, green gram dal, beaten rice, suji, cooked rice dough (ada), mango and jack fruit. Another Indian dairy product Doda barfi, made from germinated-wheat flour (angoori atta) is an excellent source of dietary fiber. The product is characterized by pleasant caramelized flavour, dark brown colour and chewy and grainy body. Sohan halwa is another germinated-wheat-based buffalo milk product, popular in North India. It has an extremely chewy texture, which is attributed to the simultaneous presence of wheat gluten and casein. Also, ghevar, a milk sweet prepared from admixture of wheat flour, is a rare delicacy of Rajasthan. Its body has a characteristic miniaturized honey comb structure that is spongy and chewy with sugar layer on top providing a glossy appearance. Falooda is a milk-based drink, flavoured with rose syrup and added with strands of corn flour vermicelli. The whole corn flour and the toppings containing cherries or dried papaya contribute to its dietary fiber content. Makkhan bada (padusha) is a fried South Indian sweet, consisting of maize or wheat flour, dahi, ghee and milk, the last being used as a kneading medium. Similarly, another South Indian khoa-based sweet dish containing fried gram flour and cashewnuts as base is Mohandas. Such combinations of milk and milk products with non-dairy ingredients enable the manufacturers as well as the consumers to choose from the variety of innovated fiber fortified products that will provide health attributes along with savour.

Commercial Fiber Preparations in Dairy Products

Commercially available fiber preparations are either insoluble type or soluble type. Use of insoluble fiber preparations has been rather limited in the dairy products. Examples include yoghurt containing wheat bran. Wheat bran has been found not to impair growth of *Streptococcus thermophilus* and appears to have positive effects on the growth of *Lactobacillus bulgaricus* in the incubation phase. Wheat bran after extrusion (high pressure and high temperature treatment) could also be added to yoghurt or quarg specialities to enhance its fiber content. Yoghurt added with commercial fibers from apple, wheat, bamboo as well as inulin has also been reported. Yoghurt fortified with inulin scored highest for flavour attributes while the yoghurt with wheat fiber scored highest for textural attributes followed by yoghurt.
with bamboo fiber. The research work regarding the fortification of some selected dairy foods like *kheer* and yoghurt with the commercial fiber preparations and their blends is under progress in dairy technology division, NDRI.

Several soluble fiber preparations are nowadays gaining popularity as a fiber ingredient for various dairy products for their several physiological and functional roles. A dietetic yoghurt containing inulin has been found to promote the growth of healthy gastrointestinal microflora. Short chain fructooligosaccharides of two to four fructose units have been claimed to be particularly suitable for incorporation into dairy products to improve the taste and texture of the product as well as to serve as bifidogenic factor to improve the intestinal health of the consumers. Inulin or oligofructose has found most useful for use in dairy products such as flavoured milk, milk drinks, fermented milk, cheeses, desserts and ice cream, as well as paneer. Addition of fermentable fiber to the milk formula has been reported to be a cost-effective way to reduce the severity of pathogenic infection-associated symptoms in infants.

Also, the soluble fibers are known to improve the body-texture and viscosity of the product without any addition of calories to the product. Due to their low calorific value, polydextrose, maltodextrin and pea fibers have been used as a fat substitute at the rate of 1.5 per cent in yoghurt. These fat substitutes were reported to affect the viscosity of yoghurt but did not alter the activity of the starter culture. Yoghurt with polydextrose scored well for the flavour and aroma attributes than did pea fiber but the yoghurt with pea fiber, P-fiber 150C had shown the least whey syneresis. Polyfructan, another soluble dietary fiber, can also be used as a low-energy bulking agent for sweeteners, viz., aspartame, or as a fat substitute in ice cream and baked cheese cakes.

Various gums from both plant and microbial sources are used in dairy industry as thickening agents, emulsifiers, and emulsion stabilizers, or to modify the structure of the product. They are able to modify fat and water-holding properties and can also control aroma and flavour release. Psyllium husk (isabgul) and gum acacia was found to be suitable as stabilizers in ice cream which gave ice cream a highly acceptable body and texture. Locust bean gum has found use in cheese and ice cream. In the former it is added to increase the yield of curd solids by 10 per cent, while in the latter it stabilizes the system and binds water allowing ice cream to withstand heat shock during storage and to melt smoothly in the mouth. It is also suitable in low-calorie milk-based salad dressings where an interactive role of gum, milk and acetic acid concentrations on emulsion consistency has been found. Carrageenan, guar gum and sodium carboxymethyl cellulose have been extensively used at low concentrations in ice cream to prevent large ice crystal formation. Carrageenan complexes with milk proteins and prevents wheying-off. Carrageenan, sodium alginate, guar gum, and carboxymethyl cellulose have also been reported to be used as thickeners in the stabilization of whey-based tomato soups. It should, however, be noted that the use of such gums as thickeners is generally at so low levels that the fiber intake through such food would be rather limited.

Soytrim, a soluble fiber preparation obtained by the thermomechanical processing of soybean and oat products, has been used in some Asian foods. Various Asian foods standardized with added Soytrim include Thai green chicken curry, fermented soybean sauce (dip), *Mungbean* conserve and sweetened condensed cassava paste. These products were enriched in soluble fiber and had reduced saturated fat content. Similarly, Oatrim, a product obtained by treating the oat flour with a food-grade enzyme, such that it contained b–glucan, a soluble fiber and amylodextrin, was successfully used in skim milk to overcome the watery appearance and bland mouthfeel and to add to it a cholesterol-lowering property. The standardized fat-free milk with added Oatrim was claimed to provide 0.8g dietary fiber per 240 ml serving.
Similar to the Soytrim mentioned above, various fiber blends are commercially available which can be consumed with milk, for example, Merecol or Sat-Isabgol, both are psyllium husk preparations. Another such product is “Nu-Rice®ceutical”, developed to deliver the nutritional and functional properties of rice bran for use in tablet-style supplements or an ingredient in fortified foods.

**Conclusion**

Literature is replete with the scientific evidence supporting the beneficial effects of fiber-rich diet. It is therefore common that doctors and nutritionists advise people to increase their intake of dietary fiber by increasing the consumption of whole grains, legumes, vegetables and fruits. Certain commercial fiber supplements have also been shown to be beneficial in the treatment of specific health problems. Physicians often recommend fiber supplements for patients with chronic constipation. Various dietary fibers have been shown in clinical studies to play an important role in reducing plasma cholesterol, improving bowel microflora and bowel function, decreasing the risks of colon and other cancers and sometimes even reducing blood sugar. Hence, dietary fiber preparations have attained a great commercial significance as nutraceuticals with considerable functional relevance in the diet in general and milk products in particular. Although a few milk products do contain dietary fiber added through fruit and vegetable ingredients, commercial fiber preparations used as non-conventional ingredients in various dairy products have a great potential to enhance their physical and physiological functionality. The single most important role that these nutraceuticals can play is to improve the sagging image of milk products on account of their saturated fat and cholesterol content. Dairy food formulations with added dietary fiber can transform the usually ‘low-residue’ milk constituents, collectively, into dietary products with their well established nutritional superiority and added healthfulness. Thus, native functional virtues of milk such as conjugated linolenic acid, certain biopeptides, whey proteins, sphingolipids etc. added with the fiber functionality would greatly elevate the status of dairy products for the benefit of consumers of all age groups.
Mammalian milk is unique in that it is one of the few substances naturally designed to sustain the newborn. Because of its ability to support growth and development, the composition of milk has been rigorously analyzed. The presence of hormones and hormone-related substances in milk was described more than 75 years ago. The finding of hormones in milk was described as early as 1929. Milk of various species contains a number of hormones of a non-peptide and peptide character as well as several hormonally active peptides. Bovine colostrum and milk are rich sources of various peptides which possess biological activity. Colostrum contains the highest concentrations of hormones/growth factors. Bovine milk has been of significant interest since it is widely consumed and used for infant formulas. Over the years, improved methodology has enabled scientists to more accurately determine the concentration of these substances in milk. Also, with the advent of recombinant protein (i.e., bovine somatotropin), public and political consciousness has been raised concerning other bioactive factors in commercially available milk. To date many hormones and growth factors have been identified in milk.

**Hormonal Bioactive Substances in Bovine Milk**


**Insulin-Like Growth Factors (Somatomedins)**

Growth hormone (GH) or somatotropin is a peptide hormone secreted from the anterior pituitary gland. GH exerts much of its effect through intermediate substances called “somatomedins” (also called “Insulin-like Growth Factors”). It is usually considered that the GH does not act directly on responsive tissues but stimulates the synthesis and secretion of these growth-stimulating factors from liver. The IGFs are mitogenic polypeptides that stimulate cellular proliferation and differentiation in a variety of cells.

At least four somatomedins have been isolated, but by far the most important of these is Somatomedin C, also called Insulin-Like Growth Factor I (IGF-I). The name ‘somatomedin’ was proposed because the biological effects observed were clearly GH-dependent and appeared to mediate some of the biological effects of GH. The name ‘insulin-like growth factors’ was given because its amino acid sequence was similar to insulin (H” 47%) and it mimicked the biological effects of insulin, in the free-state (when not associated with IGF binding proteins). In vivo, IGFs are proposed to act both as endocrine hormones via the blood and locally as paracrine and autocrine growth factors.

IGFs are members of the insulin family of growth factors, consisting of insulin, IGF-I, IGF-II and relaxin. IGF-I and IGF-II are widely distributed mediators of cellular growth, development and differentiation. IGFs are single-chain polypeptides. Both IGFs contain three disulphide bonds, and display approximately 63 % sequence homology with each other and
47 percent with Insulin. Human IGF-I consists of 70 amino acids (Fig. 1) and has a molecular weight of 7646 Da. IGF-I has a basic isoelectric point (8.5) and lacks the amino acids histidine and tryptophan. Human IGF-II has an acidic isoelectric point (<6.5) and consists of 67 amino acids, with a molecular weight of 7470 Da. The amino acid sequence of IGF-I among a variety of species, is highly conserved (quite similar). Human and Bovine IGF-I are identical. Porcine IGF-II differs from the human molecule by only one amino acid, while bovine IGF-II differs from the human molecule by three amino acids.

In vitro, IGF-II mimics all effects of IGF-I. The biological role of IGF-II is not clear and that even its biological relevance is under dispute. Truncated IGF-I (-3N: IGF-I) has also been found in fetal and adult human brain, in bovine colostrum, and in porcine uterus. Truncated IGF-I lacks the N-terminal tripeptide, Gly-Pro-Glu. The biological potency of this truncated form has been reported to be 1.4-10 times higher than that of the full-length form. Reduced binding of the truncated form to IGF binding proteins (IGFBPs) may be responsible for the increased biological potency.

IGF Receptors

The biological effects of IGFs on target cells are mediated through two types of cell membrane receptors. Two types of IGF receptors have been identified: they are IGF-I receptor type-I and the receptor type-II. The type-I receptor mediates most of the somatomedin-like actions of both IGF-I and IGF-II. The native type-I receptor is very similar to the insulin receptor sharing considerable (84%) amino acid sequence identity and has a molecular weight of ~450 KDa. It is composed of two extracellular 130-140 KDa ß-subunits and two transmembrane 90 to 98 KDa ??subunits, linked by disulphide bonds. The ??subunits contain the extracellular IGF-binding site and the smaller ??subunits traverse the plasma membrane and contain the cytoplasmic tyrosine kinase activity. Type-I receptors preferentially bind IGF-I and also bind insulin at high concentrations. The binding affinity of type I receptor is in following order: IGF-I > IGF-II > insulin.

The type-II receptor is structurally and functionally quite different from the insulin receptor and type-I IGF receptor. It is composed of a single glycosylated protein chain, ~250 KDa, which is identical to the mannose-6-phosphate (M6P) receptor. The type-II IGF receptor binds IGF-II with greater affinity than IGF-I and does not bind to insulin at all.
IGF Binding Proteins (Igfbps)

The IGFs are found in the systemic circulation and in tissues in a different, and somewhat unique manner for a protein hormone; they are stored bound to high affinity and specific IGFBPs. The bioavailability and, therefore, the actions of the IGFs are regulated, in part, by these IGFBPs that bind IGFs with high affinity. These IGFBPs make the analysis of IGF levels difficult. IGFBPs are involved in:

(i) prolonging the half-life of the IGF in the circulation
(ii) transport the IGF from the vasculature to the tissues, and
(iii) localizing IGF to specific cell types and tissues to potentiate and inhibit the biological activity of IGF.

Six distinct IGFBPs have been isolated and characterized from a variety of vertebrate species ranging from mammals to fish and enumerated as IGFBP-1, -2, -3, -4, -5 and -6 in the order in which they were discovered. All six IGFBPs have core molecular masses of 23-32 KDa. The IGFBPs are similar in overall structure, consisting of 200 to 300 amino acids. The first five IGFBPs demonstrate high affinity for both IGFs, share at least 50% homology among them, and share 80% homology between different species. Homology is most conserved at the amino and carboxy terminal regions, which are involved in IGF binding. The major variation in amino acid number and composition occurs in the middle third of the proteins, suggesting that specific amino acids necessary for IGF-binding are localized to the conserved end regions. IGFBP-6 has 100-fold greater affinity for IGF-II than for IGF-I. Structurally, all but IGFBP-6 have at least 18 cysteines (conserved in number and spacing) which may be involved in intramolecular disulphide bond formation and IGF binding. Two proteins that bind the IGF with low affinity have also been identified and designated as IGFBP-7 and IGFBP-8.

IGFs in Human Milk

IGF-I concentrations in human milk were measured during the first 9 days postpartum (Baxter et al., 1984). The mean IGF-I concentration was 17.6 ìg/L at 1 day postpartum, 12.8 ìg/L at 2 days postpartum, and 6.8 ìg/L at 3 days postpartum. After 3 days postpartum, the IGF-I concentration stabilized over the following week at 7 to 8 ìg/L. In a later study (Corps et al., 1988), IGF-I concentrations in human milk were measured and ranged between 13 and 40 ìg/L at 6 to 8 weeks postpartum with a mean of 19 ìg/L.

IGFs in Bovine Mammary Secretions

The most abundant and best characterized growth factors in bovine colostrum are IGF-I and IGF-II. Bovine secretion contains the IGFs, some IGFBPs, and IGF receptors. IGF-I and IGF-II together with a truncated form of IGF-I have been purified to homogeneity from bovine colostrum. IGFs in colostrum and milk are supposed to originate from circulation and not due to local synthesis in mammary tissues, although the exact mechanism of their appearance in mammary secretions is unknown. The relative abundance (activity) of the three forms IGF-I, IGF-II and -3N: IGF-I, was estimated to be about 1:0.05:2, respectively, in bovine colostrum, indicating that most of the IGF activity in colostrum is due to the presence of -3N: IGF-I. IGF-I in bovine colostrum and milk is principally associated with a 45-kDa IGFBP. The occurrence of IGFBP-2 and -3 in milk has been confirmed for the bovine, human and rat. Other IGFBP species also appear to be present, but to date await positive confirmation of their true identities, which potentially are IGFBP-4, -5 and -6, or perhaps proteolytic fragments of other IGFBPs from cellular or milk processing. Quantification of IGF-I and IGF-II in milk has been done by specific double-antibody radioimmunoassay (Malven et al., 1987). A summary of the published concentrations of the growth factors in colostrum and milk is shown below.
Because milk is a complex substance, inaccuracy arises from using inefficient techniques that do not adequately separate the IGFs from the interfering substances. Thus, quantification of IGFs is limited by the sensitivity and specificity of the assay. The reason for the disparity may relate also to the use of different sources of IGF-I for iodination and reference standard.

Factors Affecting IGF-I in Bovine Milk

IGF-I is present at much higher concentrations in colostrum than in blood, but, shortly after parturition, milk IGF-I falls well below blood concentrations (Baxter et al., 1984). Bovine colostrum contains much higher concentrations of IGF-I than do human colostrum (500 compared with 18?g/L) as week as with mature bovine milk (10?g/L). Bovine milk concentrations of both forms of IGFs declined rapidly after parturition. Multiparous cows had higher IGF-I concentration (306 ?g/L) at parturition than primaparous cows (147 ?g/L). By Day 2 of lactation, milk IGF-I concentrations were 30 to 50% of initial values. By Day 56 of lactation, milk IGF-I concentrations were 34 ?g/L for combined parity groups (Campbell and Baumrucker, 1989).

Einspanier and Schams (1991) reported that the highest level of IGF-I was found during the last 2 weeks ante partum, followed by a rapid decrease during the first milkings post partum. The association of IGF-I with its binding proteins in milk was also analyzed and striking differences were found in the distribution of bound and free IGF-I. IGF-I appeared mainly in the bound form (91%) at days 40-42 ante partum. Free IGF-I predominated in the first milkings post partum (73%) and changed again to about 85 % in the bound form after day 4 post partum. A slightly acidic pH (6.3) of the secretion was correlated with high amounts of free IGF-I.

Collier et al. (1991) reported that the primary factor affecting the concentration of IGF-I in milk was the cow’s farm, followed by the stage of lactation and parity. Milk IGF-I concentration was higher in early lactation than mid and late lactation with concentrations in multiparous cows exceeding those of primiparous cows. Concentration of IGF-I in bovine milk is lower than concentrations reported for human milk yet similar to those reported for human saliva. This study confirmed the large variability among farms in milk IGF-I values and demonstrated that salable milk can vary at least fivefold in IGF-I concentration. Concentrations of IGF-I in saliva and salivary production rate would suggest that intake of IGF-I via saliva (2 to 4 ?g/d) approximates the amount of IGF-I present in 0.72L of milk.

Report of Campbell and Baumrucker (1989) with Holstein cows showed that multiparous cows provided colostrum with greater concentrations (300ng/ml) of IGF-I than that of primiparous cows (150ng/ml), although such a difference was not found with the first
colostrum of Swiss Friesian-Simmental cross dairy cows. Thus breed also appears to influence the appearance of IGF-I in colostrum.

In a field study carried out in Germany (Ruffer, 2003) the results showed that the physiological parameters: number and stage of lactation, somatic cell count, class of milk yield and stage of gestation had significant influences on IGF-I concentration. The pathological parameters that had a significant influence were higher somatic cell counts and bacteriological status. IGF-I content were significantly higher in milk collected during early lactation (day 5 to 80) and late lactation (after day 240) as compared with milk collected during mid lactation. Primiparous cows gave milk with the lowest IGF-I contents, where as IGF-I contents rose significantly with the number of lactation. Pregnant cows at 35 to 100 days post coitum (dpc) gave milk with the lowest IGF-I contents. Milk of cows at more than 200 dpc had significant higher IGF-I contents than milk from non-pregnant cows and cows at less than 200 dpc. Samples with more than one mastitis pathogen had significantly lower IGF-I contents than samples with no bacterial infection or samples with coagulase negative Staphylococci.

El-Khasmi et al. (2004) reported that in camel milk IGF-I levels were high at parturition and decreased with stages of lactation.

Prosser et al. (1989) reported that there was an increased secretion of IGF-I into milk of cows treated with recombinantly derived bovine growth hormone. The peak concentration of IGF-I in the milk during rbGH treatment is lower than that of milk collected during the early stages of lactation in cows. Moreover, rbGH treatment raised the IGF-I level in cows’ milk only to a concentration equal to that of human milk collected in the sixth week of lactation. A significant proportion (19%) of the total IGF-I was present in the free unbound form. The average increase in concentration in milk is small compared to normal variations in concentration of this compound from cow-to-cow in milk from unsupplemented animals. The average increase of IGF-I in milk produced by supplemented cows is also small compared to the variation in amounts that occur normally from the beginning to end of the cow’s lactation period.

**Effect of Milk Processing on IGFs**

Of particular interest in milk is the stability of IGFs in heat and acid treatment. These characteristics contribute to the survivability of IGFs in commercial milk products and to their potential bioactivity in the gastrointestinal tract of the consumer. Pasteurization of bovine milk (79°C, 45 s) does not alter the concentration of IGF-I, but the required treatment for infant formula, 121°C for 5 min, destroys the protein.

**IGF-I and Health Related Aspects**

The Internet is full of health scares and myths surrounding IGF-I and cancer from dairy products. IGF-I is a protein hormone and hence it is digested just like any other protein in milk, meat, or other foods that you eat. IGF-I is not active when consumed by mouth. There is no evidence to suggest that oral intake of IGF-I is carcinogenic. FDA has stated that the consumption of dietary IGF-I plays no role in either inducing or promoting any human disease, nor does it cause malignant transformations of normal human breast cells. The suggestion that IGF-I in milk can induce or promote breast cancer in humans or premature growth stimulation in infants is scientifically unfounded. The quantities of IGF-I present in the daily human consumption of milk and dairy products are much lower than the total amount of IGF-I secreted daily in the gut (saliva, gastric juice, jejunal chime, bile and pancreatic juice). Even the increase in the concentration of IGF-I in milk from rbGH-treated cows is in orders of magnitude lower than the physiological amounts produced in the GI tract and other parts of the body.

Extensive studies on the safety of rbGH have been conducted world-wide and reviewed by FDA and was concluded that both milk and meat are safe. A separate review of the data has been conducted by the National Institute of Health, the World Health Organization, the...
Office of the Inspector General of the Department of Health and Human Services, and reviews by the Journal of the American Medical Association, Pediatrics, and the Journal of the American Dietetic Association all independently have arrived at the same conclusion, milk and meat from rbGH supplemented cows are safe. In addition, various regulatory agencies from countries around the world have also reached the same conclusion.

References


Role of Membrane Processing in Traditional Dairy Products

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Introduction

Since the birth of membrane technology in late sixties, extensive studies have been carried out on the various pressure driven membrane separation processes, namely reverse osmosis (RO), ultrafiltration (UF), nanofiltration (NF) and microfiltration (MF). The main objectives of these studies have been to develop newer membranes with improved properties and explore wide range of applications in food and chemical industries. Because of these worldwide efforts, many new membranes including third generation ceramic membranes, which have high temperature and chemical tolerance properties have been developed for membrane processes. The membrane technology is now successfully used for numerous applications, such as desalination of seawater, processing of foods, effluents treatment and biotechnological applications. In food processing, the dairy industry is probably the largest user of membrane technology. Some of the commercial uses of membrane processing in dairy industry are the treatment of whey and manufacture of whey protein concentrates, manufacture of several varieties of cheese, reducing bulk milk hauling costs by its preconcentration at farm, and separation and harvesting of microbial cells and products of enzymatic hydrolysis of milk constituents.

The traditional Indian dairy products have great significance in our country as more than 50% of total milk production is converted into these products. These products not only offer great employment opportunity to our large unskilled and semiskilled population but also help preserve milk solids at room temperature for longer time and provide value addition to milk. The principles involved in the manufacture of some of the traditional dairy products, such as heat desiccation (Khoa, Rabri and Basundi), heat and acid coagulation (Chhana and Paneer) and fermentation and concentration (Dahi, Chakka and Shrikhand) are compatible with that of membrane processing. The membrane processes, therefore, may play a highly beneficial role in modernization and upgradation of the technologies of our traditional dairy products. The research work carried out in this area and future scope is discussed in this write-up.

Reverse Osmosis (RO)

RO Process is also known as hyper filtration (HF). The commercial RO system normally uses the cellulose acetate, polyamide and thin film composite (TFC) membranes, the latter having better properties for food applications. The tight nature of the membranes having pore size in range of 1 to 10 Å calls for the highest operating pressures compared to the other membrane separation processes. Normally RO process operates at about 30 bar pressure for milk and milk by products. RO membranes separate solutes with a molecular weight of approximately 150 Daltons and above. Hence fat, proteins, lactose and all undissociated minerals are retained and concentrated by the membrane and only water and some ionized minerals are allowed to pass through (Cheryan, 1998). Since the RO process for removing water from liquid foods requires only mechanical energy, the most attractive feature of this membrane process is its lowest energy requirement in comparison with other dewatering processes. For example, concentration of milk by RO requires energy in range of 9-19 KWh/1000 kg of water removed in comparison with 37-52 KWh by 5-7 effect evaporator with MVR, and 92 KWh by freezing process (Marshall 1985). It can therefore be used for pre-concentration
or final concentration of liquid feed for different purposes. RO process is, therefore, quite limited in its upper solids limits. As an example, current technology permits milk to be concentrated by multiple effect evaporation to about 50% total solids, while the upper limit using RO is about 28% total solids for skim milk and 38% for whole milk (Pal and Cheryan 1987a). It is the osmotic pressure of feed and the concentration polarisation that limit the flux thereby restricting solids level in the RO process.

RO concentrates can be used in fluid form either as pasteurized or UHT processed milk and for the manufacture of spray/roller powders, yoghurt, ice cream, etc. (Pal and Cheryan, 1987b). In India, RO concentration has tremendous scope in the preparation of many concentrated traditional dairy products namely khoa, rabri, basundi, and kheer. The removal of moisture from milk is a key operation in these products.

**Khoa by RO process:** Khoa, an important Indian milk product, is a base material for several milk products of Indian subcontinent, is presently manufactured on a small scale by continuous boiling of whole milk until a desirable solids concentration (65-70% total solids) is reached. Since the traditional method involves boiling of milk at atmospheric pressure, it is highly energy intensive. In recent years, several mechanized systems have been developed for commercial production of khoa such as scraped surface heat kettles or heat exchangers. The use of preconcentrated milk has been suggested in such methods for higher output and better thermal efficiency of plant. In this context the application of reverse osmosis for pre-concentration of milk prior to the manufacture of khoa has great potential in India. Cow milk pre concentrated to 2 folds (Pal and Cheryan, 1987a) and buffalo milk to 1.5 folds (Kumar and Pal, 1994) by the RO process followed by atmospheric boiling in a steam kettle was successfully used for the preparation of khoa. Except higher retention of moisture and lower free fat in the khoa made from RO concentrated milk, no other significant changes were noticed in comparison of control product. But an energy saving of over 400 kcal/kg milk compared with scraped kettle and over 100 kcal/kg milk compared with evaporators could be achieved by preconcentration of milk having about 12.5% solids to about 31% solids using RO process (Cheryan et al., 1987). Development of a continuous commercial method for making khoa is also possible by combining RO plant with scraped surface heat exchanger or any other suitable unit.

**Other traditional desiccated dairy products:** Rabri and basundi are partially concentrated and sweetened traditional milk products. Whereas rabri contains several layers of clotted cream (malai), basundi has either smooth consistency or small grains of coagulated milk solids. Traditionally, both these delicacies are prepared from milk by private traders (Halwais) at a very small scale by simmering whole milk in a shallow kettle for a prolonged period and adding sugar after achieving the desired concentration. Pal et al. (2002) recommended a commercial method of preparing rabri using RO process as an intermediate step of the production line. The method involves pre concentration of standardized milk to about 24% total solids in a RO plant, addition of sugar to this concentrated milk and generation of characteristic cooked flavour by heating the mixture to about 95°C followed by final desiccation to about 50% total solids in a scraped surface heat exchanger. The desired flaky texture is simulated by adding shredded (very thin slices) paneer to hot sweetened desiccated milk. The shredded paneer in not required in the preparation of basundi. Dahi is another important traditional fermented milk product where RO can play an important role. Dahi made from cow milk is weak and fragile in comparison with buffalo product. This problem is due to lower protein and calcium contents in cow milk, which are responsible for firmer curd. Partial concentration of cow milk to about 1.25 to 1.5 folds level by using RO system and preparing dahi from it adopting standard method has been found very useful in producing dahi similar to that buffalo dahi (Pal, et al., 2002). The use of RO concentrated milk having more than 1.5 fold concentration was, however, found to be inferior due to insufficient flavour development.
(Kumar and Pal, 1994). Sachdeva et al., (1994) reported manufacture of ‘Chakka’ from milk concentrated by reverse osmosis (RO). Cow milk, standardized to fat: SNF ratio of 1:2.2 (12.5% TS), was pasteurized and concentrated (2.5 fold) using and RO plant equipped with tubular, polyamide membranes. A temperature of 50°C and a pressure of 30 kg/m² were used for concentration. The concentrate was subjected to heat treatment of 90°C/5 min, cooled to 22°C, cultured at the rate of 2% with a mixed strain lactic culture and incubated for 18 hours. The coagulum then obtained was filtered and a minimal amount of whey (4.5 lit./40 lit. of coagulum) having 18% TS was removed from it to get the chakka. They reported a yield of 35.5% of chakka by RO process as compared to 28.3% in case of conventional chakka.

**Nanofiltration**

NF, also known as loose RO process, falls between RO and UF as far as pore size of the membrane and operating pressure are concerned. The pore size of NF membrane ranges from 10 Å to 100 Å and operating pressure ranges between 25-30 bars. NF membrane allows water and small univalent ions (Na+, K+, Cl-) to pass through it whereas completely rejects lactose and other macromolecules. This membrane process is, therefore, used for partial demineralization and concentration of fluid feeds. The principal application of this membrane process in dairy industry is for separation of minerals from whey. Kelley and Kelley (1995) reported 64-70% (on dry basis) reduction in the chloride and overall reduction of ash to about 25% in whey by NF process. Most recently, the NF process has been tried for processing cow milk for improving the quality of traditional dairy products (Pal et al., 2002).

The quality of traditional products, particularly khoa, paneer and dahi, is inferior to their counterpart buffalo milk products, which is attributed to inherent compositional differences. Cow milk contains high chloride content, which imparts salty taste to these products, particularly khoa. The lower contents of fat, proteins and lactose in cow milk in comparison to buffalo milk are responsible for sandy texture in khoa, hard and very compact body in paneer and weak and fragile gel of dahi in addition to low yields of all products. According to the studies conducted by Pal et al. (2002), cow milk was heated at 72°C and concentrated to about 1.5 and 2.0 folds using NF membrane system at 50°C. The results of these experiments revealed that NF reduced the salt content of cow milk up to 74% in 1.5 fold concentration with out affecting other major constituents. Khoa prepared from this milk did not taste salty and the texture was comparable to buffalo khoa, thereby improved the acceptability of cow khoa. The organoleptic quality, particularly in respect of body and texture, of dahi also improved significantly when prepared from 1.5 folds NF concentrated cow milk. Paneer prepared from normal cow milk has hard, compact and dry characteristics. NF of cow milk though helped overcoming these defects and produced better quality paneer, but imparted excessive brittleness. Khoa and paneer prepared from NF milks also had higher moisture retention resulting in higher yield. The nanofiltration process is being successfully used by a dairy plant in Canada for the manufacture of khoa from cow milk.

**Ultrafiltration (UF)**

The mechanism of separation in ultrafiltration is essentially a sieving process in which constituents of a feed stream are separated according to their molecular weight. The ability of the membrane to retain the majority of defined macromolecules of known molecular weight is generally used to specify the porosity of the membrane. The term used is molecular weight cut-off (MWCO), which should be the molecular weight of the smallest test macromolecule that is largely rejected by the membrane. Most UF membranes reject the constituents having a molecular weight larger than 1000 Dalton. Since the majority of UF membranes have pore sizes ranging from 1 to 50 nm, essentially all milk constituents except water, lactose, ions and some water-soluble vitamins are rejected. Ultrafiltration membranes are completely
impermeable to lipids and proteins and substances bound to them. Though a large number of membrane materials are available, all of them do not have commercial application in food processing. Cellulase acetate (CA), polysulphone (PS) and ceramic membranes are more commonly used for UF process (Cheryan, 1998; Pal, 2003). In fact PS is considered a breakthrough for ultrafiltration because of its several unique advantages, such as very good operational and cleaning compatibility and flux rates. These membranes are configured in to four commercial models, namely tubular, hollow fiber, plate and frame and spiral wound, and each of these has its own characteristics.

**Chhana by UF process:** Chhana is an Indian ‘heat-acid’ coagulated soft cheese. It serves as a base material and filler for a large variety of Indian sweet meats notably Rasogolla and Sandesh. Traditional method of chhana making is principally a method of concentrating protein and fat of milk by the action of heat and acid and simultaneous removal of most of lactose and minerals in form of whey. A similar function of concentrating protein and fat in retentate and removal of lactose and minerals in permeate (same as whey) is achieved by the UF process but with out the action of heat and acid. Because of this similarity in two processes, UF process has been attempted by many workers for the manufacture of chhana. Sharma and Reuter (1991) used skim milk ultrafiltered-diafiltered retentate as a base for chhana making. They heated skim milk to 95°C for 5 min., ultrafiltered it to about 26% TS followed by diafiltration by adding equal amount of water to the retentate. For preparation of chhana the retentate was mixed with plastic cream to a protein/ fat ratio of 0.722. The mixture was heated to 85-90°C/5 min. and coagulated with dilute lactic acid to develop the characteristic flavour and texture. The coagulated mass was subsequently pressed to remove free moisture. This process compared to traditional method has reported about 18-19 percent extra yield of chhana. In addition to higher yield, easy automation and flexibility in operation are claimed to be other advantages of this method. Kumar *et al.* (2005) observed that preparation of chhana adopting UF method of Sharma and Reuter (1991) resulted in to harder product unsuitable for making sweets of good quality. They recommended the addition of coagulant to UF-DF retentate at room temperature followed by heating the mixture at 60°C for preparing chhana with higher moisture and of soft body and suitable for making good quality rasogolla and sandesh.

**Chakka and shrikhand by UF process:** Chakka is a concentrated fermented dairy product in which milk proteins with or without fat are concentrated and most of the lactose and minerals are removed in whey. It is used as a base for preparation of shrikhand. The traditional method, which involves removing whey by hanging the curd (dahi) in a cloth bag, is highly time consuming and results in to high losses of milk solids. Sharma and Reuter (1992) recommended UF process for chakka making to overcome these inherent problems associated with the traditional method. They claimed that 23.16% higher yield of chakka can be obtained by adopting the UF process and shrikhand of very good quality can be prepared from the UF chakka.

**Rasogolla mix powder by UF process:** The technology of manufacturing ‘dried rasogolla mix’ has been developed using UF process for concentration of milk proteins and removal of lactose and minerals. It was followed by diafiltration of retentate to further reduce the lactose and minerals, addition of cream and additives and finally spray drying of retentate (Pal *et al.*, 1993). The rasogolla powder had a shelf life of about five months at room temperature and produces sweet of highly acceptable quality.

**Paneer by UF process:** Paneer is a traditional heat-acid coagulated milk product and it is very popular all over India. Typically paneer is white in appearance with spongy body, close kint texture, possessing sweetish-acidic nutty flavour. Paneer manufacture essentially involves heat/acid coagulation of standardized milk followed by pressing of the coagulum. The existing batch manufacturing technique is labour and energy intensive and is susceptible to environmental contamination.
Membrane processing has a potential application in the manufacture of paneer. Ultrafiltration (UF) when employed for paneer manufacture offers advantages like access to mechanization, uniform quality, improved shelf life, increased yield and a nutritionally better product. The process developed (Sachdeva et al., 1993) involves standardization and heating of milk followed by UF whereby lactose, water and some minerals are removed. UF of milk and the removal of permeate is synonymous to removal of whey by coagulation in conventional method. The concentrated mass, which has about 40 per cent total solids, is cold acidified to get the desired pH. Till this point, the product is flowable and can be easily dispensed into containers with automatic dispensing machines. The filled containers are then subjected to texturisation by microwave heating in a domestic microwave oven. This can also be achieved in a continuous process by using microwave tunnels. Such tunnels comprise of a series of magnetrons under which the product moves continuously on the conveyor belts. The resulting product has typical characteristics of normal paneer.

In another approach, a in-package process was developed using UF process for manufacturing long shelf life paneer-like product (Rao, 1996). Standardized buffalo milk is concentrated partly by vacuum concentration process and partly by employing UF to a level of total solids desired in the final product. After packing in moralized polyester pouches, product is formed by a texturising process at 115°C, which permit concomitant sterilization. The process permits greater product yield due to retention of whey solids, being 35 per cent as compared to 15 per cent obtained by conventional batch process.

**Microfiltration (MF)**

The development of MF as a means of bacteria and spore removal of suspended particles that include lipids, bacteria and spores from milk (Cheryan, 1998) has generated much interest about the new technologies for the manufacture of long life products. The pore size of the MF membrane ranges from 0.1 to 1.4 micron and operating pressure from 1 to 25 psig. Possible uses of MF include delipidization of whey, shelf life extension of liquid milk, production of cheese with minimal risk of blowing and without nitrate addition, and several biotechnological applications. In case of traditional dairy products there appears to be no direct application of MF, but it can be used to improve the microbiological quality of milk intended for use in the manufacture of traditional dairy products.

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**PPD-1**  
**Effect of Calcium Chloride and High Heat Treatment on the Yield of Direct Acidified Cottage Cheese**

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Recovery of whey proteins, decreasing curd fines losses and improving the ability of curd to hold moisture appear some critical approaches to result in a product with reasonably higher yield. In the present study, attempts were made to increase yield of direct acidified cottage with the addition of CaCl₂ alone as well as in combination with higher heat treatment. The effect of CaCl₂ alone added @ 0.012, 0.016 and 0.02% as well as with high heat treatment at 85, 90 and 95°C for 5 min on the total protein and whey proteins contents (DM basis), moisture retention and the resultant curd yield as well as the quality of cottage cheese was studied. It showed that CaCl₂ @ 0.02% significantly (P<0.01) increased the curd yield to 12.76% against 12.16% for the control with an additional increase by 4.93%, mainly because of the increased (P<0.01) moisture retention of 74.80% compared to the control (74.35%). While CaCl₂ @ 0.02% along with heat treatment at 90°C/5 min enhanced (P<0.01) the curd yield to 13.52% compared to the control sample by about 11.18%. The treatment significantly (P<0.01) increased the whey proteins and total protein contents to 13.93 and 87.69% against the control with the corresponding values being 73.41 and 1.20%, respectively with an improved (P<0.01) moisture retention of 75.10% compared to the control (74.35%).

**PPD-2**  
**Value Added Camel Milk Products**

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Camels’ milk is considered as one of the most valuable food in arid and semiarid and it is cost effective in comparison of cow and goat due to its longer lactation length and better adoptive mechanism to retain and dissipate heat without affecting the milk production. The important features of camel milk are lower percentages of fat, total protein and total solid while higher percentage of total salts free calcium, protective proteins and vitamin C, and some of micro minerals viz iron, copper and zinc etc. along with therapeutic merits in some of diseases viz dropsy, jaundice, tuberculosis, asthma, anemia, piles and diabetes type-1. In order to promote utility of camel milk in certain hilly and mountain areas predominant with large female camel population. Various camel milk products viz camel fermented milk (lassie), soft cheese, flavored milk and kesar kulfee were developed, standardized and evaluated at the farm level successfully. The camel milk was fermented using four different lactic starter cultures. Camel milk was coagulated by the addition of calcium chloride at the rate of the 0.02 percent followed by the 50 percent diluted HCl at the rate of the 4-ml per liter milk. Flavoured camel milk was processed with different combination of flavours with use of of carrageenan stabilizer (@ 0.04% and sugar at the rate of the 3.5- 5 percent. Camel milk Kesar Kulfee is prepared by using sugar at the rate of 5 percent and Kesar at the rate of 0.01-0.02 percent followed by boiling and is concentrated to approximately 2.5:1 ratio. Overall acceptability was recorded more than 80 percent for all the value added products.
**PPD-3**  Utilization of Double Toned Milk Filled with Coconut Milk for the Preparation of Rosogolla

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The investigation was undertaken to standardize the manufacturing technique of Rosogolla from Coconut milk filled Doble Toned Milk and evaluate the physico-chemical changes and sensory qualities during manufacture and storage. Coconut Filled Milk was standardized to a fat level of 3.5% and coagulated at pH 5.6 with 1% lactic acid solution at 70°C for preparation of Rosogolla. It was found that Cooking syrup of 60% sugar concentration, cooked for 25 minutes and soaking syrup of 40% sugar concentration yield most suitable quality of Rosogolla. The average total solid, fat, protein, sucrose and ash content in coconut filled Rosogolla were noted as 47.38, 5.39, 5.61, 32.58 and 0.38% respectively. The Coconut Filled Milk Rosogolla was found to be slightly harder, more whitish in comparison to cow milk Rosogolla. The product has also some coconut flavour. It was found that Coconut Filled Milk Rosogolla remained in good condition for 5 days at 35±1°C and 15 days at 7±1°C, respectively.

**PPD-4**  Microfiltration: Technology for Value Added Dairy Processing

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Many of the advances in membrane technology have been fuelled by the demands and advances in microfiltration (MF) technology as applied to the dairy industry. MF, along with other membrane filtration processes like ultrafiltration, reverse osmosis and nanofiltration, is making it possible to produce products with very unique properties and functionalities.

Microfiltration (MF) is a low pressure membrane separation process for separating colloidal and suspended particles in the range of 0.05-10 microns. Since the 1980s, MF has been investigated as a competing technology to centrifugation for clarification and bacteria removal of milk and whey. However, available polymeric membranes such as polysulfone, and polycarbonate, were not ideal in terms of chemical stability. The advent of ceramic membranes provided an excellent opportunity in terms of chemical and thermal stability. Also the concept of ultrasonic cleaning of membranes has provided new vistas for cleaning of membranes. The technological advances like uniform transmembrane pressure (UTMP), Multichannel arrangements to hollow fiber bundles, vibratory shear-enhanced (VSEP) filtration etc, have made MF a leading process among other emerging technologies.

Cross flow microfiltration (CFMF) technology is rapidly gaining prominence in the processing of dairy ingredients. CFMF has emerged as an industrial separation technology in the dairy industry for at least three main applications: (i) removal of bacteria (ii) whey defatting and (iii) micellar casein enrichment of the cheesemaking, but numerous other applications are currently being investigated, such as selective separation of somatic cells from raw whole milk, whey or milk protein fractionation or milk fat separation. Microfiltration is also used for fermentation, broth clarification and biomass clarification and recovery.
PPD-5  Unique System for Continuous Manufacture of Various Indian Milk Products

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India is top milk producer in the world, with an average production of around 81 mmt. It is estimated that about 50-55% of the total milk production is converted into traditional milk products. With the rapid growth of dairy industry in our country, the technology and design of process equipments is also undergoing changes. The small-scale technology for the preparation of these products can not be exploited for industrial production. Besides, the higher profitability of traditional dairy products has acquired interest in mass production. These products have also got great export potential because of the GATT agreement, which facilitate free trade through the opening of potential market and reduction in export subsidies.

Continuous process obviates all disadvantages associated with batch process. Thin film scraped surface heat exchanger is used as mechanization tool for large scale production of Indian milk products owing to its unique performance characteristics i.e. short residence time, small hold-up volume and handling viscous products with minimum drop in heat transfer coefficient.

This paper presents the performance of unique system (one machine only) for continuous manufacture of Indian milk products i.e. ghee, khoa, Burfi, rubry and basundi.

PPD-6  Standardization of the Method for the Preparation of Pizza

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Pizza market amounts to over Rs 102 crore and is growing very fast @ 30% per year. In order to overcome the variation from place to place, the method for pizza preparation was standardised. Three groups were taken differing in the type of cheese used (A: 100% Mozzarella cheese; B: 80% Mozzarella cheese + 20% Cheddar cheese; C: 80% Mozzarella cheese + 20% Processed cheese). For preparing pizza in microwave oven, 8” pizza crust was subjected to grill mode for a minute, and before pouring generous layer of tomato sauce, a coating of butter was applied to enhance the flavour as well as for the good storage capability of pizza. Then different combinations of grated cheese (150 g) were spread evenly on the pizza crust. Finally on the top of the crust sliced onion, tomato, capsicum, chillies, and grated ginger were placed in definite proportion followed by baking in preheated oven with combination mode [convection (200 °C) + microwave] for 7-8 minutes. Once baked, pizza was allowed to stand for a minute before cutting to make it crisp. Sensory quality of the three groups of pizza was evaluated by ranking and hedonicity test by sensory panel comprising of five judges for its flavour, body & texture, appearance and overall acceptability. The results showed that amongst the three groups studied, pizza made from B had the highest preference followed by C and A respectively.
Role of Automation & Instrumentation in Equipment Design for Manufacture of Value Added Dairy Products

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Automation and instrumentation has become an important component of today’s dairy industry. It has an important role to play in manufacture of quality Value Added Dairy Products. Automation and instrumentation helps in assuring high quality of Value Added Dairy Products with optimal processing. Hygienic design of sensors and transducers employed in instrumentation and automation is very essential requirement in equipment design for manufacture of Value Added Dairy Products. The appropriate material of sensor in contact with product, proper way of mounting them and trouble free working of sensors helps in minimizing contamination to get quality Value Added Dairy Products.

The material of construction of instruments, sensors, transducers in direct contact with product must be approved for food contact. It should be constructed from appropriate materials and if they contain transmitting fluids, such as in a bourdon tubes, pressure gauges, then the fluid must be approved for food contact. Hygienic installation of instruments and automatic control devices are also important for maintaining quality of the final product. Controls, particularly those that are repeatedly touched by food handlers to allow process operation should be designed to prevent contamination and should be easily cleanable. Pathogenic microorganisms have been known to harbor in switches and be transferred to the product every time they are operated. With the development of automatic processing equipments the chances of contamination through such causes have reduced considerably.

Biosensors can play a vital role in quality processing of Value Added dairy Products. There is increasing demand of biosensors for on-line/real-time monitoring and controlling the quality attributes of food products, because it provides rapid measurements. Development of enzymatic biosensors as an integral component of food processing is progressing rapidly. The advantages of optical biosensors are speed of detection. Biosensors are also used for food safety to detect presence of genetic modification, toxic substances, pathogenic organisms etc. and there by it helps to assure quality processing of Value Added Dairy Products.

Variable Frequency Drive (VFD) can save up to 40-80% of energy costs depending on the system load and motor efficiency. Further it allows flexibility in control of speed and process to obtain required product quality particularly in relation to rheological aspects. We have tried Variable Frequency Drive (VFD), Model No: VT 130 S, Volts: 415, Input Amp: 5.3, Output Amp: 4.0, 36 Phase, for getting variable speed of scraper drive unit of SSHE for manufacturing Value Added Dairy Product-Basundi at SMC College of Dairy Science, AAU, Anand. We have reduced rpm of scraper assembly in the later stage of processing from 35 rpm to 15 rpm to have typical textural characteristics of basundi i.e. flakes. VFD is very much useful in controlling speed of scraper assembly and there by controlling the rheological properties of basundi.

Automation and Instrumentation helps in Value Added Dairy Product development with better quality attribute, as per consumers demand. It also helps to save energy and time of processing with assured quality of the final product.
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The present conventional method of Basundi making is a manual operation. In this system, heat is supplied at the bottom surface of the vessel and milk is continuously stirred by a person. Traditionally Basundi is made by heating the milk, generally standardized at 5% Fat for buffalo milk and 4% Fat for cow milk and Fat: SNF ratio of 0.5 in the shallow karahi over gentle fire or it can be made in a stainless steel steam jacketed kettle at around 0.8 to 1.0 kg/cm² pressure, under constant agitation with the help of a ladle. But in both the methods main problem is lack of uniform heating and agitation, which results in to lack of uniformity of rheological quality of Basundi. Further basundi making by conventional methods of karahi and open pan heating is a time consuming, energy intensive and laborious process. To overcome the problem of energy consumption, lack of uniformity of rheological quality as well as large scale production, we have tried stainless steel (S.S) version of SSHE, developed by Dairy Engineering Department, SMC College of Dairy Science, AAU, Anand and we have assessed the feasibility of S. S version of SSHE for Basundi making. Basundi was successfully made by employing Conical Vat SSHE and Horizontal Cylindrical type SSHE.

Different types of mechanized heat exchangers, which were available and designed at SMC College of Dairy Science, AAU, Anand were used to make Basundi i.e. (i) Jacketed kettle (ii) Conical vat with mechanized scraper (iii) Horizontal cylindrical type Scraped Surface Heat Exchanger (SSHE) (iv) Vacuum pan (v) Combined Vacuum pan & SSHE (vi) Combined RO plant & SSHE. It was found that U-value for Jacketed kettle, conical vat, horizontal SSHE, Combined Vacuum pan & SSHE and Combined RO plant & SSHE were 775 W/m²°C, 1644 W/m²°C, 1600 W/m²°C, 1937 W/m²°C and 2200 W/m²°C respectively. The water evaporation rate in kg/hr. was found as 11, 04, 25, 42, 22 and 40 respectively. The following table gives comparison of energy consumption and processing cost of different mechanized methods of basundi making.

The cost of basundi. making in Rs./kg were found as 6.80, 7.00, 3.25, 2.75 and 3.55 for Jacketed kettle, conical vat, SSHE (20 kg batch), SSHE (40 kg batch) and combined vacuum pan / SSHE respectively. The cost of making Basundi by combined RO plant & SSHE were not calculated, and it still requires more trials to be conducted. In the SSHE batch size of 40 kg, steam pressure of 1.5 kg/cm²(g) and 35 rpm speed is optimized to have economical production of basundi.

We have tried Variable Frequency Drive (VFD), Model No: VT 130 S, Volts: 415, Input Amp: 5.3, Output Amp: 4.0, 3ô Phase, for getting variable speed of scraper drive unit of SSHE. We have reduced rpm of scraper assembly in the later stage of processing from 35 rpm to 15 rpm to have typical texural characteristics of basundi i.e. flakes. VFD is very much useful in controlling speed of scraper assembly and there by controlling the rheological properties of basundi.

We have modified blade design with Teflon coating to prevent metal traces coming in the product and to overcome problem of burnt/brown particles in the final product. The relation obtained between effective revolution of scraper assembly rand overall heat transfer coefficients for different angles of blades i.e. 120°, 140°, and 180° and blade angle of 120° is selected based on optimization of effective rpm of scraper assembly.

The available different types of mechanized heat exchangers at SMC College of Dairy Science, AAU, Anand, were tried to make Basundi and to assess feasibility of mechanization
of Basundi making. This gave sufficient data to decide economical heat utilization for Basundi making and to design prototype continuous basundi making machine. The data collected are analyzed for overall heat transfer coefficient of heat transfer and cost per kg of Basundi making. The study is useful to optimize processing parameters and to decide higher capacity of the equipment for Basundi making in dairy plants at low cost.

The product was compared favorably with the conventional method in the sensory and rheological profile, with better score of flavour and color. The product is having uniform and consistent quality in all the batches.

PPD-9 Possibility of Utilizing Whey Protein Concentrate as a Nutritional Adjunct and Functional Ingredient in Dietetic Ice-cream

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It is recommended that not more than 30 per cent of calories consumed in the human diet should come from fat. This has led to a surge in the development, production and consumption of reduced-fat products. Home made medium-fat (5%) vanilla flavoured ice cream was prepared using a basic mix including micro-particulated buffalo Whey Protein Concentrate (WPC-70) at three levels i.e. 1.00% (P1), 1.25% (P2) and 1.50%(P3) by weight of ice cream mix. Ice creams P1, P2 and P3 were compared with full-fat (11%) control (C), which was devoid of WPC.

Sensory evaluation of hardened ice cream indicated that flavourwise C was preferred the most followed by P2, P1 and P3. Sample P1 was criticized for lacking in richness, whereas P3 was criticized for having whey protein flavour. Body and texture of C and P2 were regarded as soft, smooth and rich. Sample P1 was criticized for its heavy body and lacked desired richness and mouthfeel, whereas P3 was criticized for being foamy, gummy and sticky. Regarding melting quality, sample P3 had the least melting resistance compared to others. Though P2 had better gloss than others, none of the samples differed significantly (P<0.05) from each other. The overall total score was in the order: C=P2 > P1 > P3.

Use of micro-particulated WPC (70% protein) at 1.25% level in reduced-fat ice cream is recommended.
PPD-10  Ohmic heating - A tool for value addition in dairy products

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At the international level, demand for value added products is tremendously increasing and milk being highly perishable commodity needs value addition. It is achieved through a number of processing operations that include heating, fermentation, use of osmotic dehydrants or natural microbial inhibitors and preservatives as value addition tools. Among these, thermal processing have been playing major role. However, traditional thermal technologies have many inherent drawbacks such as fouling, low thermal efficiency, localized heating, need of scraping in processing viscous and particulate products, etc. To overcome these drawbacks and achieve value addition of international quality Ohmic heating is the promising solution.

Ohmic heating is a food processing method in which an alternating electrical current is passed through a food sample, which results in internal energy generation in foods and gives much faster and uniform heating. Due to less come-up time, the heating and holding times can be precisely monitored. Heat transfer surface being absent in ohmic heaters, they can be easily cleaned as well as no thermal losses due to convention and conduction like conventional heating occur. It is considered environment friendly, as it does not produce any emissions like flue gases or ash. As far as microbial destruction is concerned, in addition to thermal effect, a mild electroporation was found to contribute in cell inactivation due to lower frequency voltage (50-60Hz) used in ohmic heating and it yields higher Reaction Rate Constant (K) and lower Thermal Death Time (T) for some microorganisms viz., E. coli, Bacillus subtilis and Zygosaccharomyces bailii.

Potential applications for ohmic heating include blanching, evaporation, dehydration, fermentation and extraction. In addition to dairy industry, it is being widely used for thermal processing of fruits, fruit juices, egg products, etc. in Japan, UK and USA. Ohmic heating is very useful tool for dairy processing operations involving heat transfer which is yet to be exploited by Indian Dairy Industry.

PPD-11  Process Standardization of Chhana Spread

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Process was standardized to prepare chhana spread from the blends of chhana and chakka with addition of salt. Spread was prepared by blending chhana and chakka with addition of different levels of salt. Results indicated that channa spread made with incorporation of 1% salt was more palatable as compared to that of 0.5 and 1.5 % salt. Blending of chakka in different proportions with chhana significantly influenced the sensory quality of spread. Blending of chakka with chhana to the extent of 20% (80:20 proportion) resulted in a spread which was superior in sensory quality as compared to other proportions. With further, increase in proportion of chakka to 30% the sensory quality of chhana spread affected adversely. Chemical quality of spread reveals gradual increase in moisture but decrease in total solids, fat and protein content with increase in proportion of chakka. However, the chemical constituents of chhana spread made by blending 80:20 proportion of channa and chakka were within the limit.
PPD-12 Optimization of Processing Parameters for Preparation of ShrikhanDwadi

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Attempt has been made to standardize the process for preparation of shrikhandwadi from cow milk chakka. Product was prepared by blending cow milk chakka with 75, 100 & 125 % sugar and fortified with different levels of skim milk powder. Result indicated that the sensory scores in respect of body and texture, flavour and overall acceptability of shrikhandwadi improved significantly with increase in sugar levels from 75 to 125 %. Shrikhandwadi made by blending 125% sugar with chakka was more acceptable as compared to other two sugar levels. Further, the sensory quality of shrikhandwadi was improved with fortification of 10% skim milk powder. Addition of higher level of skim milk powder (15%) resulted in decline in sensory scores of all the attributes, except body and texture, which increased with increase in skim milk powder.

Textural quality of shrikhandwadi made by blending chakka and 125% sugar improved significantly with fortification of 10% SMP without adversely affecting the sensory quality of product. Chemical quality revealed that the total solids, protein and total carbohydrates content of shrikhandwadi increased marginally due to incorporation of 10% SMP as compared to that of control.

PPD-13 Utilization of Karonda (Carissa carandas L.) Juice in the Manufacture of Flavoured Milk

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An experiment entitled “Utilization of Karonda (Carissa carandas L.) juice in the manufacture of flavoured milk” was carried out with the view to determine the optimum level of Karonda juice in the Karonda flavoured milk. The extracted Karonda juice @ 5,10 and 15 per cent and sugar @ 5, 7.5 and 10 per cent of milk along with suitable stabilizer (gelatin @ 0.5%) were added. Amongst the nine different combinations Karonda juice @ 10 per cent and sugar @ 7.5 per cent produced the flavoured milk with the highest score of 7.60 rated at 9 point hedonic scale. The final product, thus, produced had 4.05 per cent fat, 20.197% total solids, 3.16 per cent protein and 0.177 per cent acidity as against 4.22, 20.978, 3.45 and 1.148 per cent fat, total solid, proteins and acidity in control sample of the flavoured milk. On the basis of overall acceptability and chemical composition of the product (Karonda flavoured milk) it is concluded to use 10 per cent Karonda juice and 7.5 per cent sugar alongwith 0.5 per cent gelatin for preparation of flavoured milk.
**PPD-14** Process Optimization for the Manufacture of Chhana Prepared by Admixing Sweet Cream Buttermilk to Buffalo Milk

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Admixing 60% sweet cream buttermilk to buffalo milk, on total solid basis, has been reported to give desired chhana. An investigation was undertaken to optimize temperature and pH of coagulation for further quality improvement of chhana thus prepared. For this, different temperature (70, 75, 80 and 85°C) and pH (5.8, 5.6, 5.4 and 5.2) of coagulation were studied. As the coagulation temperature increased, there was significantly lower (p<0.05) moisture content in chhana. Optimum quality of chhana was obtained at coagulation temperature of 75°C. At 75°C coagulation temperature, as the pH of coagulation of chhana decreased up to 5.2, there were significantly (p<0.05) lower % total solids in whey (6.15%) and there was significantly improved body and texture (p<0.01), but no significant difference in flavor, color and appearance of chhana. Thus the optimum temperature and pH of coagulation were observed to be 75°C and 5.2, respectively. The sensory body and texture score of chhana produced under optimum conditions was judged to be 8.02 on 9-point Hedonic scale. Optimized chhana had 5.585 mN hardness, 3.239 mN gumminess, 28.441 mm.mN chewiness and tested 57% moisture, 22.40% fat, 16.73% protein, 1.89% lactose and 1.98% ash. Rasogolla prepared from optimized chhana, scored 8.12 on 9-point Hedonic scale on sensory evaluation.

**PPD-15** Utilization of Bullocks Heart (Annona reticulata L.) Pulp in Preparation of Ice Cream

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The investigation on ‘Utilization of Bullocks Heart (Annona reticulata L.) Pulp in Preparation of Ice Cream’ was undertaken to access its acceptability and then to optimize its level. Three levels of bullocks heart pulp viz. 4, 8, and 12 per cent and two levels of stabilizers viz. Zero and 0.15 per cent sodium alginate were used and six treatment combinations obtained compared within themselves and with . Vanilla ice cream was kept as a control sample.

The overall acceptability score of ice cream ranged from 86.63 to 94.85 control samples of vanilla flavoured ice cream secured highest sensory score (94.85) which was at par (94.15) with the ice cream having 4 per cent bullocks heart pulp and no stabilizer. All the samples were acceptable but the acceptability was decreased with increase in the pulp level and use of stabilizer. The ice cream prepared from 4 per cent bullocks heart pulp and no stabilizer had 36.43 per cent TS, 10.02 per cent fat, 4.174 per cent protein, 20.81 per cent total sugar and 36.02 per cent overrun when frozen in softy machine.

The cost of production of most acceptable bullock heart ice cream was Rs. 58.60/kg.
PPD-16  Addition of Buffalo Milk Burfi with Pulses

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Suitability of Pulses (Chana or Moong) was examined for the preparation of buffalo milk Burfi. Admixture of different levels of khoa, pulses (Chana or Moong) was tried in the present study. Burfi prepared from a mixture of buffalo milk khoa, chana dal and sugar in the ratio of 60:10:30 was found to be most suitable on the basis of sensory and chemical quality. On an average, the best product combination contained 19.23, 21.70, 11.05, 14.68, 9.03 and 2.62% moisture, fat, protein, lactose, sucrose and ash respectively. The product was in good condition up to 21 days, stored at refrigerated condition. Chana dal burfi samples treated with potassium –meta-bi-sulphite (800 ppm on the basis of milk) was found acceptable up to 15 days at 30± 1° C and 30 days at 7± 1° C during storage.

PPD-17  Improving Value Addition in Dairy Products by Microencapsulation

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Microencapsulation offers alternative methods for the development of functional dairy products. Preventing ingredient-ingredient interaction, extending shelf life, and improving handling are important characteristics of microencapsulation that can add value to a formula. It can provide novel solutions to problems encountered in the development of healthy properties of dairy foods. Many of the most popular nutritional ingredients on the market today have unpleasant sensory characteristics; microencapsulation is useful in keeping the objectionable flavours out of the products and keeping the enjoyable flavours in.

Long chain Omega-3 fatty acids have been implicated in reducing the risk of heart disease, inflammatory and immune disorders and have a role in improving early development. Using microencapsulate long-chain polyunsaturated oils eliminates fishy odour and taste and enables the development of improved products enriched with these fatty acids.

The ability of vitamins to maintain activity in dairy products depend on pH and reactions to heat, light, oxygen, oxidizing agents and enzymes. Using microencapsulated vitamins in dairy products reduces loss during storage. In the dairy industry, liposomes containing enzymes have been reported to reduce the ripening time by 30-50% as well as improve texture and flavour.

Calcium and iron have mainly been used for fortification, but there is a growing interest in fortification of foods with other minerals, such as magnesium. However, it is known that undesirable interactions between unprotected mineral salts and components in milk can lead to precipitation, colour and flavour problems. Encapsulated mineral salts lessen the tendencies for undesirable interactions.

Probiotic bacteria can be added as live cultures in dairy products but their growth and survival in fermented products can be a problem. Microencapsulation of probiotic bacteria can improve its survival during storage.
PPD-18  Studies on Preparation of Pomegranate Yoghurt from Cow Milk

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The investigation ‘Studies on Preparation of Pomegranate Yoghurt from Cow Milk’ was undertaken to find out the optimum level of fruit with its suitable form (juice, arils or their combination) that could be incorporated to obtain the best quality value added pomegranate yoghurt. Chemical composition, sensory quality and cost of production were also studied.

It was observed that addition arils (grains) of Arakta cultivar of Pomegranate @ 10-15 per cent before incubation in unstirred form with addition of 3-6 per cent sugar was more acceptable.

The Pomegranate yoghurt with 10 per cent fruit arils and 6 per cent sugar was sensorily superior (score 92.98) than that of control samples prepared without pomegranate arils and sugar (score 87.95). The best pomegranate yoghurt contained 3.20 per cent fat, 21.20 per cent TS, 5.76 percent reducing sugar, 13.53 per cent total sugar, 1.09 per cent acidity and pH 4.52.

The cost of production of most acceptable pomegranate yoghurt containing 10 per cent fruit arils and 6 per cent sugar was Rs. 28.41/kg.

PPD-19  Incorporation of Karonda (Carissa carandas Lam.) Pulp in Ice-Cream

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The present investigation was undertaken with view to explore the feasibility of incorporation of karonda pulp as natural flavouring agent in ice-cream. Different types of ice-cream using 0% (To), 10% (T1), 20% (T2) and 30% (T3) karonda pulp (w/w) were prepared using standard procedure (De, 1992). The fat and total solids contents in all treatments were adjusted to about 12 per cent and 38 per cent, respectively.

Milk used for ice-cream preparation contained 4.5 per cent fat and 8.5 per cent SNF content. Karonda pulp had 19° Brix total soluble solids, 10.22 per cent soluble sugar and 0.35% acidity.

The average moisture, total soluble solids, total sugars, titratable acidity content pH of karonda pulp was 72.36%, 19°Brix, 10.22%, 0.345% and 2.72% respectively.

The ice-cream with 20% pulp had the highest overrun (49.15%) and overall acceptability (7.515) in comparison to control and other treatments.

Ice-cream prepared with 28.37 per cent milk, 32.01 per cent cream, 7.21 per cent skim milk powder, 11.92 per cent sugar, 0.5 per cent sugar, 0.5 per cent gelatin and 20 per cent karonda pulp had the highest score for organoleptic qualities namely general appearance, body and texture, flavour and overall acceptability. This revealed that incorporation of karonda pulp at 20 per cent is the most desirable and acceptable. Addition of karonda pulp in the ice-cream mix at freezing stage is appropriate. Incorporation of karonda pulp in ice-cream as natural flavouring agent also has special significance in human diet from the view point of nutrition.
PPD-21  Dietary Supplement for Cardio-Vascular Health

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Diseases of the circulatory system account for an appreciable proportion of total morbidity and mortality in adults worldwide. According to WHO estimates, 16.7 million people around the globe die of cardiovascular diseases each year. Nearly one-fifth of the deaths in India are due to coronary heart disease (CHD), major factor being changes in dietary pattern and sedentary lifestyle. The drugs available are more aggressive and are often associated with side effects. However, no supplement is available in Indian market for CHD patients. A dietary supplement for management of cardio-vascular disease was formulated. The formulation consisted of fat blend containing milk fat and vegetable oil to have sufficient w-3 fatty acid (11.73%) with an accelerated stability time of 336 hrs. The formulation also contained Inulin as dietary fibre (6 -10%) so as to meet the necessary requirement for benefit of patients suffering from CHD. Calculated amounts of antioxidant vitamins namely, vitamin A, vitamin E and vitamin C were dry blended in the spray-dried product, to makeup for the loss of these vitamins during processing. The efficacy of the formulated dietary Supplement was determined through animal bioassay technique. The In-vivo studies for 90 days feeding revealed that 20% supplementation helped reduce plasma triglyceride (TG) content by 37.36%, plasma cholesterol by 13.19%, LDL-Cholesterol (LDL-C) by 15.02% and VLDL-Cholesterol (VLDL-C) by 42.24% while plasma HDL-Cholesterol (HDL-C) was increased by 18.69%. Increasing the supplementation level showed further reduction in plasma lipids viz. cholesterol, TG, LDL-C and VLDL-C and an increase in HDL-C. The contents of various lipid fractions in aorta region showed reduced deposition of TG to 1.95 mg/g tissue as compared to control group 2.92 mg/g tissue. The faecal lactobacilli count was found to increase and faecal coliforms count was lowered in experimental group showing added beneficial effect of dietary fibre as prebiotic.
Process Modification for Development of Chakka

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Quality of fermented dairy products is somewhat unpredictable even when manufactured under optimum conditions of production. Hence there has always been an interest in exploring the possibility of utilizing certain chemical and/or biochemical substitute to starter cultures. Chakka, an indigenous milk product obtained by draining off the whey from curd (dahi) made by lactic fermentation of skimmed milk or whole milk, is widely used as the base material for production of shrikhand. Few attempts have been made to develop ‘chakka’ by direct acidification process. The present investigation is an attempt towards overcoming the constraints encountered in use of starter by adopting direct acidification process for production of chakka using buffalo skim milk.The effect of pH of coagulation (4.8, 5.0 and 5.2), incubation temperature (30°C, 35°C and 40°C), type of acid used (lactic and hydrochloric acid) and their dilution (1:6 and 1:9) on sensory quality of direct acidified chakka was studied. The sensory evaluation of chakka for flavour, body & texture and colour & appearance showed that optimum quality of product could be obtained by using a combination of lactic acid (1:9 dilution) and glucono delta lactone (2.5%), coagulated at pH 4.8 and incubation temperature of 35°C. The chakka obtained from conventional and direct acidification was found to have similar sensory characteristics.

Studies on Development and Standardization of Sterilized Carrot Based Flavoured Milk

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Carrot (Daucas Carota) is highly valued for its nutritional and therapeutic properties and carotenoids content. The high intake of carotenoids help in decreasing the incidence of some diseases like cancer, muscular degeneration, cardiovascular and pathological processes in human health. Carrot juice is also helpful in growth of bifidobacterium bifidum in the infant’s digestive system. Since, there is a need to develop the milk products based on carrot because the carrot combine with milk gives a healthy, tasty, safe, and nutritious food. In order to get all these requirements in single ones this study was undertaken.

In the development of this product natural colour and flavour of carrot would eliminate the addition of artificial colour and flavour to the flavoured milk. Carrot based flavoured milk have been developed using 10, 20 and 30 percent carrot juice and shredded carrot with 15 percent sugar. The product was sterilized and stored at room temperature for chemical analysis and sensory evaluation. The sensory evaluation of the product was carried out on 9 point Hedonic scale. The flavoured milk containing 20 percent carrot for juice and shredded was preferred mostly by the judges. The product was well accepted upto 1 month of storage at room temperature.
In the recent past there has been an increase in the market share of foods having functional attributes. Today consumer also demands foods that are of health benefits. With increase in the consumption of bread, the consumption of spread to compliment with has also increased. Therefore it seems appropriate to develop a table spread with advantageous functional attributes.

A low fat table spread has been formulated having specially designed lipid phase expected to be beneficial in lowering the LDL, VLDL cholesterol in blood plasma. Various blends of milk fat and vegetable oils were subjected to GLC analysis and best blend was selected to provide requisite levels of w-3 fatty acid (11.73%) and maintaining a ratio of w-6/w-3 fatty acid was 1.67%. the table spread was prepared using different levels of skim milk powder (SMP), whey protein concentrate (WPC) and processing temperature. The spread containing 12-15% SMP, 2-3% WPC processed at 75°C, which secured higher sensory scores of 7.8, 8.1 for body & texture and spreadability respectively using 9 point hedonic scale. Increasing the level of WPC rendered the product having coarse and pasty texture. The spreadability of the spread was found to decrease with increase in the level of SMP Incorporation of dietary fiber was also attempted. The spread containing 4 to 6% oat fiber resulted in lowering of sensory and rheological properties of resulted spread. Whereas Inulin at 4.2-4.8% level provided excellent body texture and spreadability characteristics. An attempt to incorporate dietary fiber was made in view of their ability to help in lowering blood serum cholesterol level. The optimum levels of various ingredients were determined through CCRD technique.

The present investigation was conducted to study the feasibility of utilization of whey as Oral Rehydration Solution. A market survey was conducted to know the exact composition of WHO recommended ORS formulations available in the market. Paneer whey was defatted, deproteinized, cultured and given enzymatic treatment to make four kinds of bases for ORS. Another two kinds of ORS formulations to be prepared at household level were also tried by using whey (without processing) and honey. These bases were analyzed for their chemical composition and then the required electrolytes were adjusted according to WHO recommendations. Analysis of all the ORS formulations revealed that the composition of ORS formulations was at par with WHO recommendations. These formulations were offered to judges for sensory evaluation by adding orange and mint flavours. Judges preferred without essence formulations due to inclination towards natural aroma and taste of whey as compared to flavoured formulations. Thus, whey a by-product of dairy industry can be economically utilized for the treatment of gastrointestinal disorders.
**PPD-26** Studies on Development and Standardization of *Doda Burfi* (Sprouted Wheat Based Milk Product)

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*Doda Burfi* is one of the traditional Indian cereal based milk product of Punjab. Traditionally, *Doda Burfi* is made by crushed wheat grains (*sanmak*), wheat flour, sugar and ghee in different proportions. The combination of lysine-rich milk protein with lysine-deficient cereals such as wheat delivers the synergistic effect, which imparts a high nutritional profile in the products. This product gives excellent flavour and fulfills the requirements of nutritious foods.

Sprouts are predigested food; they have high biological efficiency value than whole grains. In sprouted wheat, vitamin B-12 quadruples, other B vitamins increases 3 to 12 times and vitamin E content triples as compared to wheat grain. Sprouting the wheat improves digestibility and increases bioavailability of protein, carbohydrates and vitamins. They possess high nutritional and therapeutic properties.

There is a need to standardize the process of manufacturing *Dada Burfi* and further improve its properties by replacing *sanmak* by dried sprouted wheat grains. For this purpose, an experiment was conducted with three levels of dried sprouted wheat grains (5, 7, 9 percent) and three levels of sugar (7, 8, 9 percent) and the percent of wheat flour and ghee were kept constant @ of 2 percent each. On sensory evaluation of the samples on 9-point hedonic scale the most acceptable combination found is 7 percent dry sprouted wheat grain, 7 percent sugar and 2 percent wheat flour were identified with respect to milk.

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**PPD-27** Technology of Kalakand Preparation By Standardization of Milk Ingredients

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For the preparation of kalakand cow milk (C), buffalo milk (B) and cow and buffalo mixed milk 50:50 (M) were selected. Citric acid (0.05%) water solution was added in the milk at boiling (within 5-6 minutes) stage (*S₁*) at 50% concentration (*S₂*) and at dough stage (*S₃*). The level of fat (5%), solids-not-fat (10%) and added sugar (6%) in all the milk samples were constant. All the treatment combinations were repeated thrice during experimentation.

The average yield of kalakand was apparently highest in milk B (28.11%) than milk C (27.44%) and milk M (28.00%). Irrespective of milk, the average yield of kalakand prepared at stage (*S₁*) (28.78%) was significantly (P<0.05) higher than stage (*S₂*) (26.89%). The total solids in kalakand was also higher (P<0.05) at stage (*S₁*) (72.73%) than the value obtained at stage (*S₃*) (71.99%) in all types of milk. The amount of fat and total ash did not show significant difference within the samples. The flavour and body & texture score of kalakand was significantly (P<0.05) higher at stage *S₁* than *S₃*. The differences in colour score of the samples were not significant. Kalakand samples required less time (P<0.05) when citric acid was added in the milk at boiling stage *S₁* than at stages *S₂* and *S₃*.
Development of Milk Based Junket Like Product from *kutki* grains

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The modern trend for development of new food products aspires for complementary foods in order to fulfill the widening gap of food availability and nutritional security. The present research work confines in the product development of *kutki* grains by taking milk as the base materials. *Kutki* (little millet) is leading produce under the categories of minor millets and constitute the food of the economically weaker sections of dry land regions in India. Nutritive value of *kutki* is comparable or even superior to that of major cereals like rice and wheat. *Kutki* is a popular food among diabetic patients and helpful in lowering Coronary Heart Diseases incidence, because of its low in saturated fatty acids, rich in carbohydrate and dietary fiber content. Keeping above points in view, efforts have been made to develop a technology for production of milk based junket like product from *kutki* grains.

Three levels of *kutki* flour as well as of sugar powder i.e. 10, 20, and 30 percent of milk were tried in product formulation. On the basis of sensory evaluation and statistical analysis, the product made from *kutki* flour level of 10 percent and sugar level of 30 percent was found more acceptable on sensory characteristics of products. This combination of product was also found to be techno-economically feasible.

Effect of Vacuum Packaging on Texture Profile of Brown Peda During Storage

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Peda is one of the popular khoa based sweet in India. Several varieties of peda viz., plain, kesar, brown (lal), etc are available in the market. Amongst these brown peda is more popular because of its longer shelf life and taste and also used as “Prasad” at many religious places. Though it has longer shelf life but the oxidation of fat and the microbial growth is normally encountered during storage. Very high shelf life is claimed by the manufacturers but, because of high fat content product develop oxidized flavour and it is the major problem. Because of this vacuum packaging has been attempted. The mould growth on the product is another problem i.e. faced. Vacuum packaging has been found beneficial for many dairy products including milk sweets such as burfi. However vacuum packaging is known for its high compression impact on the texture of food products. Peda is known for its round shape and differentiates from burfi and other khoa based sweets partly because of shape also. In this situation it was planned to study the effect of vacuum packaging on the texture profile and shape of the product. In the present study brown peda was prepared from buffalo milk having 5.89% fat and 9% SNF. Cooking of khoa followed by blending sugar (Boora) with continuous stirring and scraping till the brown colour appears followed by cooling and preparing flat round shape balls. This is vacuum packaged in multi layered packaging material having gas barrier property and stored at 30°C and analyzed for texture profile after 10 days interval using Microstable Texture Profile Analyser fitted with a 25 kg load cell operating in two cycle mode, with cross head speed of 2.5 mm/sec. and observed that the control sample was 8686, 14500, 23572 and 31557 g hardness, while corresponding value of the vacuum packaged sample was 8884, 9808, 10348 and 11324 g respectively. Similarly Adhesiveness of the control sample was decreasing while vacuum packaged sample shows increase in adhesiveness. And rest of the parameters viz., cohesiveness, gumminess and chewiness in both the samples shows increasing trend.
**PPD-30 Development of Technology for Extended Shelf Life Mango Lassi**

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Owing to expanding market share and size of dairy companies, there has been a reduction of clearly structured markets i.e. merging of dairy products and fruit beverage markets with introduction of ‘juiceceuticals’ that include hybrid products like fruit based cultured milk beverages. Inclusion of mango pulp in Lassi would not only help in its value addition but also help in reducing the post harvest losses in fruits. If the shelf life of Mango Lassi could be extended it would offer stiff competition to expensive soft drinks in the beverage market. This study was carried out with the objectives to optimize ingredients for the formulation of Mango lassi, stabilization of the Mango lassi thus developed using combination of Exopolysaccharide (EPS) secreting cultures and pectin and finally extending the shelf life of Mango lassi using biopreservatives. The individual and interactive effects of milk fat, sugar and Mango pulp on sensory and physicochemical properties of Mango lassi were studied using Response Surface Methodology with Central Composite Rotatable Design (3 variables and 5 levels each). The optimum formulation conditions of 1.25 kg milk fat, 14.4 kg sugar and 10.99 kg Mango pulp per 100 kg curd were recommended for the blend formulation. A good quality, highly stable mango lassi with less than 1% whey separation was thus obtained using EPS cultures in combination with pectin. The shelf life of Mango lassi was further extended to 50 days using Microgard as biopreservative.

**PPD-31 Studies on Development and Standardization of Sterilized Carrot Kheer**

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Traditional Indian Dairy Products contains a significant proportion of milk nutrients and therefore are highly nutritious. Carrot is most commonly used for preparation of the carrot halwa in the northern and central part of the India. It is available for a short duration in the market. There is a need to preserve it most effectively and economically. An attempt was made here to develop sterilized carrot kheer not only for their taste and delight of eating but also for their high nutritional quality and better shelf life.

For preparation of the carrot kheer shredded carrot was cooked, in presence ofghee to develop characteristic flavour. Other ingredients like milk, sugar and dry fruits were added to it and the whole mass was cooked till the desired consistency was obtained and then sterilized it. Shredded carrot was added at three different levels of 20, 30 and 40 percent with 8 percent sugar. The sensory quality of the kheer was evaluated using 9 point Hedonic scale. The carrot kheer containing 30 percent shredded carrot was preferred mostly by the judges. Despite the improved shelf life, palatability, and acceptability, product also posses improved taste and nutritional quality. Quality of the products was well within acceptable limit upto 1 month of storage at room temperature. Carrot halwa as an end product can also be obtained.
PPD-32 Effect of Different Packaging Materials on the Headspace Volume of MAP Mozzarella Cheese Stored at 7 ± 1°C

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The technology of packaging products in modified atmosphere is the most advanced food preserving technique with many advantages. Attempts were made to study the effect of different packaging materials on the headspace volume of MAP mozzarella cheese stored at 7 ± 1°C for 12 weeks. For packaging and storage of mozzarella cheese, high barrier bags namely Cryovac (70 m) (P₁) and LLD/BA*/Nylon-6/BA*/LDPE (110 m) (* poly binding agent) (P₂) were used and their water vapour transmission rates were 0.5-0.6 g/sq in./24 hrs and 3.96 g/sq m/24 hrs respectively, while the oxygen transmission rates were 3-6 ml/sq m/24 hrs and 36 ml /sq m /24 hrs respectively. The freshly prepared mozzarella cheese balls (300 g each) were individually packaged in sterilized bags under different atmospheres (atm), i.e air (atm 1), vacuum (atm 2), 100% CO₂ (atm 3), 100% N₂ (atm 4) and 50% CO₂ / 50% N₂ (atm 5). The initial values for headspace volume (ml) in P₁ and P₂ packed under atm1, atm 2, atm 3, atm 4, and atm 5 were 65, 0, 625, 625, 625, which increased to 4 and 5 in case of P₁ and P₂ under atm2, while the values decreased to 607, 613, 602; and to 601, 609, 600 for P₁ and P₂ respectively in case of samples packed under atm3, atm4 and atm5 after 12 weeks of storage. Analysis of variance established significant (P< 0.01) difference towards headspace volume among the 5 types of modified atmospheres, and interaction between atmospheres and packages during storage. The influence of intervals of storage and types of packaging material, both individually, were not significant.

PPD-33 Consumer Acceptance of Soft Serve Soy Ice Cream

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Present investigation was conducted in the Department of Animal Husbandry and Dairying, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during January - June 2003 to know the consumer acceptability of ice cream prepared from blend of cow milk and soy milk in different proportions. Investigations were laid as a factorial randomized block experiment involving five different administered extent of replacement of cow milk with soymilk. Besides, five stabilizers viz. gelatin, agar-agar, gum acacia, sodium alginate and sodium carboxy methyl cellulose (CMC) @ 0.35 percent were used. The experiments were replicated thrice and total 75 samples of soy ice cream were served to a panel of expert to judge the product on 85 points ADSA scorecard for flavour, body & texture, colour & appearances and melting quality and on 9-point hedonic scale for overall acceptability. The data obtained were statistically analyzed and found that as the concentration of soymilk increased beyond 50 percent in whole cow milk, the score awarded to flavour, body and texture, colour and appearances decreased irrespective of the type of stabilizer used whereas melting resistance of ice cream increased with the increase of percent of soy milk. Finally the ice cream samples with 50 percent replacement of cow milk with soymilk were offered to consumers to know the consumer acceptability on 9 point hedonic scale and it was found that, irrespective of the type of stabilizers used the consumer acceptability score at 50:50 level of cow milk and soy milk was between 7 to 8, which were at par to the ice cream prepared from whole cow milk sample.
PPD-34  Development of Process for Instant Dalia Mix

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**Dalia**, a wheat-based, particulate containing dairy dessert is popularly consumed as a breakfast food and is also considered as a health food. However, its limited keeping quality even under refrigeration and lack of an industrial process for its large-scale manufacture, has not allowed it to come out of the confines of the domestic kitchen. In order to promote dalia dessert as a marketable product, a process was developed for manufacture of instant dalia mix, as a dry product with long shelf-life, which could be attractively packaged and easily reconstituted for consumption, any time, any where.

The process consisted of separate drying-cum-instantization of the milk and wheat phases of the product, followed by dry blending of sugar and instanized dalia grains in the powder. Instant dalia mix (complete with dalia grains) contained 3.33% moisture and 12.70% fat, 13.11% protein, 2.58% ash, 8.41% free fat and 6.54% amylose. The dalia mix powder was analysed for its physico-chemical properties. The freshly prepared powder had a good flowability (angle of repose, 53.31°) and fairly high loose and packed bulk densities (0.58 g/cc and 0.81 g/cc, respectively) corresponding to a particle density of 1.38 g/cc, occluded air content of 1.30 cc/100g, interstitial air content of 51.25 cc/100g and porosity of 38.56 %. It showed an insolubility index of 2.5 ml, wettability of 35.66 seconds, and dispersibility of 78.84 %. Reconstitution in boiling water yielded a product, which was highly acceptable.

In its sensory status, the product was comparable to conventional dalia. In the consumer survey studies, the product was ‘extremely liked’ by 22% respondents, 66% ‘liked it very much’, 11% ‘liked it moderately’ and only 1 respondent rated the product as ‘liked slightly’ indicating that the product had a high acceptability rating. The production cost of instant dalia mix was estimated to be Rs. 17.00 per package of 160 g (enough for reconstituting into a quantity for 4 servings) assuming a multi-product unit with spray drying facility could easily use its spare capacity for dalia mix production. The process developed for dalia mix manufacture appeared to have a considerable potential to facilitate commercial manufacture and marketing of this popular dairy dessert as a means of value addition and product diversification to the farmers’ milk as well as farmers’ wheat.

PPD-35  Effect of Carbohydrate Based Fat Replacer on the Sensory Properties of Low Fat Vanilla Ice Cream

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The purpose of this research was, to examine the effect of carbohydrate based fat replacer ‘Inulin’ on the sensory and physical properties of low fat vanilla ice cream. Low fat vanilla ice creams (4% fat) were formulated with three levels of inulin viz. 2.0%, 2.5% and 3.0% and products were offered to a panel of expert to judge it on nine point hedonic scale. Descriptive sensory analysis disclosed that ice creams made with 2.0% and 2.5% inulin have less creamy flavour and melted faster than 10% fat ice cream whereas samples with 3.0% inulin were found comparable to the controlled ice cream with 10% fat in terms of flavour, body and texture, melting quality and the over all acceptability.
Development of an Industrial Process for Long-life Dalia Dessert

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Dalia is a popular Indian dairy delicacy, gaining prominence for its healthful properties. A process for large-scale manufacture of shelf-stable, ready-to-serve (RTS) dalia dessert was developed using in-can retort technique.

Screening of five different wheat varieties of durum (3) and non-durum (2) types helped select the Triticum durum variety WH-896 as the most suitable one for dalia making. Preliminary studies involving various formulation aspects of retort processing of canned dalia dessert without adverse effects on the product enabled quality enabled identification of the range of nisin level (0-800) and thermal process value $F_0$ (4-8) to be integrated into a two-factor Response Surface Methodology (RSM) design. Thirteen experiments planned using the Central Composite Rotatable Design (CCRD) were conducted and the product monitored for fresh-status quality and changes during storage at 37°C. The data were analyzed employing the Design Expert software, which yielded an optimized response in terms of product’s sensory acceptability and shelf life. The optimally processed dalia dessert in 175 ml tin-free steel cans employing a rotary retort would keep well for at least 72 days at 37°C, i.e. at an average ambient temperature of 30°C it would have a shelf life of several months. The product contained on an average 3.7% fat, 3.6% protein, 0.8% ash, 21.5% total carbohydrate and 29.6% total solids. Such a processing option could be expected to help commercial production and wide scale marketing of the product along modern lines thus effectively serving the purpose of value addition and market expansion for the dairy industry.

Technology for the Development of Pineapple Flavored Lassi Like Beverage

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Cultured dairy products are an excellent medium to generate an array of products that fit into the current consumer demand for health-driven foods. Incorporation of fruits in our traditional fermented milk products would not only aid in value addition and product diversification but also help in checking the post harvest losses and economic loss to the nation. This study was carried out to optimize ingredients for the formulation of Pineapple lassi i. e. Pineapple flavored cultured milk beverage. The individual and interactive effects of milk fat (0.48 - 5.52 %), sugar (8 – 12 %) and Pineapple pulp (4 - 8 %) on sensory and physicochemical properties of Pineapple lassi were studied using Response Surface Methodology with Central Composite Rotatable Design (3 variables and 5 levels each). A total of 20 trials were conducted according to the RSM design and optimization was carried out using Design Expert – 7.0 software. The most acceptable Pineapple lassi formulation was finally selected by maximization of all the sensory responses.
**SQM-1** Shelf Life Extension of Direct Acidified Cottage Cheese using MicroGARD

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Direct acidified cottage cheese could be kept well for only 10 to 12 days under refrigeration on account of its high moisture (~74%) content and relatively high pH (~5.0), which poses problems in its widespread marketing and distribution. The study was, therefore, undertaken to improve the keeping quality of direct acidified cottage cheese using MicroGARD 400, a natural line of antimicrobial ingredients developed to assist manufacturers in meeting consumers’ demands for fresh-testing foods with reliable shelf life. The effects of three different levels of MicroGARD 400 viz. 0.20, 0.35 and 0.50% on the physico-chemical, microbiological and organoleptic properties were studied at four-day interval during storage under refrigeration (4-5°C). Promising results were found using 0.50% MicroGARD 400 for inhibiting yeasts and molds as well as psychrotrophs in cottage cheese. Use of 0.50% MicroGARD 400 was observed to significantly retard the acidity development and proteolysis in cottage cheese, thus extending its keeping quality. On the basis of its effect on the rate of changes in quality of the product during storage and the shelf life achieved, it was found that cottage cheese added with 0.50% MicroGARD™ 400 experienced noticeably slower rate of changes in quality attributes with respect to sensory quality, physico-chemical attributes as well as microbiological parameters as compared to the control sample. It was also observed that addition of MicroGARD 400 at the level of 0.50% considerably improved the flavour as well as the aesthetic quality of the product during storage as well as extended the shelf life of cottage cheese from 12 to 26 days with an additional shelf life of 14 days, corresponding to an increase in keeping quality by ~117% in comparison to the control sample.

**SQM-2** Effect of Sonication on Antioxidant Activity of Milk

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Milk is a complex food whose consumption confers a number of nutritional benefits and antioxidative defense against oxidative stress. Free radical scavenging (FRS) activity of milk serves as an important nutritional property to gauze the potential benefits against oxidative damage and various diseases. Besides, FRS components such as proteins, vitamins, enzymes and other small molecules (urate, biliverdin etc.) present in milk play an important role in preventing lipid peroxidation and maintaining quality of milk. Different processing treatments are known to influence the antioxidant potential of milk. Cow and buffalo milk adjusted to different fat levels of 0.5- 4.5 % and 0.5 - 6.0 %, respectively, were subjected to pasteurization (72°C, 15s) / sonication (0.5-15 min. at 500W at a temperature < 40°C) and evaluated for their antioxidant activity using 2,2’ azinobis 3-ethyl benz thiazoline 6-sulfonic acid (ABTS+) cationic radical as indicator reagent. It was expressed as equivalent to mM of Trolox, a water soluble vitamin E analogue as reference antioxidant. With the increase of fat content, the antioxidant activity increased both in sonicated and unsonicated milk; however, it was more in case of buffalo milk as compared to cow milk. Sonication resulted in a decrease in antioxidant activity both in cow and buffalo milk. Further, with the increase in time of sonication there was a continuous decrease in antioxidant activity of milk.
SQM-3  Probiotic Fermented Health Food: Possible Applications in Clinical Antidiarrhoeal usage

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A probiotic fermented health drink was developed by fermentation of an autoclaved and cooled slurry of rice, defatted soya flour, skimmed milk powder and fresh tomato pulp (2: 1:1:1, w/w) with Lactobacillus acidophilus (10^5 cells/ml), a probiotic organism at 37ºC for 24h. Such fermented mixture inhibited the growth of pathogenic organisms, namely shigella dysenteriae, Salmonella typhosa and Escherichia coli. A significant decline in pH with a corresponding increase in titratable acidity due to probiotic fermentation occurred in the developed food mixture. Feeding of the freshly developed fermented mixture to mice suffering from E. coli induced diarrhoea, could help to arrest diarrhoea, reduce moisture, protein and ash contents in their faeces. The counts of lactobacilli increased whereas those of E. coli decreased remarkably in the faeces of mice from the 3rd day of the feeding trial till the end of experimental period. The beneficial effect of probiotic feeding may be due to antimicrobial substances produced by L. acidophilus, which might have neutralized the enterotoxins from E. coli.

SQM-4  Proteolytic Changes during Ripening in Coconut Cream Filled Gouda Cheese

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Filled Gouda cheese was manufactured from cow skim milk and coconut cream. The extent and characteristics of proteolysis were monitored during the 4 months of ripening in terms of soluble protein, ripening index, PAGE pattern of protein breakdown and peptides by RP-HPLC. Results were compared with control. The soluble protein content and ripening index in the control as well as the filled cheese increased during ripening. There was no significant difference in these parameters between the two cheeses. The electrophoretic pattern of cheese revealed that a_1-casein degraded preferentially over b-casein in both the cheeses. The extent of a_1-casein breakdown increased with increasing storage till the end of ripening. b-Casein on the other hand, was largely unaffected up to 2 months of storage. At any sampling age, the PAGE pattern of the control and filled cheese were similar, suggesting that the mode and rate of protein breakdown were similar in both the cheeses. Peptide profiles obtained by RP-HPLC of both the cheeses were almost similar throughout the ripening period. Total area of the peaks in both hydrophilic (HI) and hydrophobic (HO) regions was higher in control than that of filled cheese. The total area of the peaks in hydrophilic region increased up to 2 months and decreased thereafter. Same pattern was observed for the hydrophobic peptides in both the cheeses. There was no significant difference in HO/HI ratio between control and filled cheese. However, effect of ripening on HO/HI ratio was highly significant.
Ghee, most widely used Indian dairy product, is prepared from cow or buffalo milk or combination thereof. Ghee contains 0.25-0.4% cholesterol. Owing to the reported adverse effects of dietary cholesterol, a simple process using adsorption principle has been developed which eliminates 90% of ghee cholesterol. Low cholesterol ghee developed through this process perfectly meets the standard specifications of ghee under Prevention of Food Adulteration and AGMARK rules. The average RM value, Polenske value, BR reading at 40°C and FFA (% oleic acid) in case of cow control ghee and low-cholesterol ghee were 29.45, 1.60, 42.65 & 0.186, and 29.69, 1.60, 42.60 & 0.173, respectively. The corresponding values in case of buffalo control ghee and low-cholesterol ghee were 32.88, 1.58, 41.73 & 0.172, and 32.70, 1.58, 41.50 & 0.161, respectively. This indicates that these values have not shown much variation between control ghee & low-cholesterol ghee even after physical removal of cholesterol from ghee. The iodine values of cow control ghee and low-cholesterol ghee were 35.16 and 34.49 and that of buffalo control ghee and low-cholesterol ghee were 31.89 and 32.15, respectively indicating that low-cholesterol ghee did not differ much from control ghee samples.

The investigation was undertaken to study the shelf life of dahi and yoghurt prepared using milk and milk-soymilk blends supplemented with sugar and skim milk powder. The samples packaged in plastic cups were stored at room (37°C) and refrigeration (7°C) temperatures and changes in acidity, sensory characteristics, total viable count and yeast and mould count were recorded. The acidity increased, scores for flavour and overall acceptability decreased with progress in storage. The total viable count decreased whereas yeast and mould count increased during storage at both the temperatures. The rate of change in acidity, sensory characteristics and microbial counts was faster at room temperature than at refrigeration temperature. The shelf life of both the products was found to be 1 day and 10 days at room and refrigeration temperatures, respectively.

Foam is generally defined as gas dispersed in liquid in such a ratio that its bulk density approaches that of gas rather than liquid. Foaming is a desirable functional property of milk used for the preparation of beverages like coffee and tea. Foaming provides economic benefits to the beverage vendors because of higher volume of the product per unit volume of milk used; it also improves consumer appeal. The aim of the study was to compare the foaming properties of various commercial types of milk in Bangalore. It was observed that skim milk gave the maximum foam capacity and foam stability, while full cream milk gave the minimum. The foaming capacities and foam stabilities followed the order: skim milk > cow milk > homogenized toned milk > toned milk > full cream milk.
SQM-8 Application of Bacterial Spore as Biosensor in Detection of Coliform in Milk

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Spore based biosensor appears to have great potential to replace the conventional quality control tests. They are cost effective, rapid, easy to perform and require almost negligible infra-structural facilities with broad range of applications at various stages of production and processing. Till date, spore based biosensor detection system have limited application in antibiotic detection, however, its potential can be applied in dairy industry for checking the efficacy of heat treatment during pasteurization/sterilization, detection of post pasteurization contaminants like coliform, GNB, psychrotrophs, enterococci etc.

An analytical process was optimized for detection of coliform in raw milk within 6-8 hrs based on indirect germination of spores of B. stearothermophilus 2922 using beta galactosidase activity and lactose as germinogenic substrate. A concentration of cell pellet (100 ml) after 4 hrs pre-treatment of milk sample in MacConkey's broth at 37°C and lactose (100 mg) was optimum for spores germination and outgrowth within 2 hrs of incubation at 55°C. The enzyme treatment time with lactose was optimized at 30 min. Raw milk with initial counts of 2500 to 2,50,000 cfu/ml could be detected within 2 hrs of incubation at 55°C prior to 4 hrs pre-treatment in MacConkey's broth at 37°C. Heat-treated cell pellet could not develop any color change after incubation at 55°C, indicates inactivation of beta galactosidase enzyme.

The analytical process can be adopted for industry after its calibration with the existing MPN method and solid agar medium as specified in the BIS standards.

SQM-9 Effect of Fat/Protein Ratio of Cow Milk Adjusted to Preceded Value using UF Cow Skim Milk Retentate on Yield and Composition of Channa

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Five lots of channa were prepared from cow milk after adjusting the fat/protein ratio of milk to 1.1 (T2), 1.0 (T3), 0.9 (T4) and 0.8 (T5) using ultrafiltered cow skim milk retentate (total solids 22%, protein 9%). The yield and composition of channa using these treatments were compared with control (i.e. cow milk channa fat/protein = 1.4, T1). In this study four replications were taken.

The study indicated that there was a significant increase in yield of channa from T1 (22.3%), T2 (22.97%), T3 (23.30%), T4 (24.10%) and T5 (25.8%). The chemical composition of channa was also significantly affected (P< 0.05) by adjusting the fat/protein ratio of milk. With the decrease in ratio of fat/protein there was an increase in protein content from 19.72(T1) to 23.15(T5) and ash content from 1.63 (T1) to 1.90(T5). Also there was a significant decrease in moisture content from 54.71 (T1) to 52.17(T5) and fat content from 23.33 (T1) to 17.0% (T5).
SQM-10  Status of Vitamin B\textsubscript{12} in Milk

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Vitamin B\textsubscript{12} is present in milk and meat products but absent in plant products. Therefore, milk is the only source of this vitamin for vegetarian population. An ELISA method for the estimation of vitamin B\textsubscript{12} was evaluated for its applicability in milks from different species. The vitamin B\textsubscript{12} levels (mean ± SE) in cow, buffalo and goat milk were found to be 4.9 ± 0.40 ppb, 21.7 ± 2.69 and 3.9 ± 0.26 ppb, respectively. The reliability of the ELISA method was checked by adding 3 and 6 ppb vitamin B\textsubscript{12} to milk and the recovery was quantitative. Estimation for vitamin B\textsubscript{12} by ELISA is simple, reproducible, does not involve the use of highly toxic chemicals such as Na/K cyanide (as in microbiological assay) and the results can be obtained on the same day.

SQM-11  Effect of Selected Strains of \textit{Streptococcus Thermophilus} and the total Solids on the Status of Acid Production, Lactic Count, Lactose And β-galactosidase Content During Production and Storage of Cow Milk DAHI

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This study was planned and conducted to evaluate the comparative performance of three promising strains of \textit{Streptococcus thermophilus} namely D-3 (C\textsubscript{1}), MD-2 (C\textsubscript{2}) and MD-8 (C\textsubscript{3}) isolated from market samples of DAHI and to assess their feasibility for Commercial manufacture of DAHI from standardised Cow milk adjusted to 12 (T\textsubscript{1}), 15 (T\textsubscript{2}) and 18 (T\textsubscript{3}) per cent total solids and 3 per cent fat in each by adding condensed cow skimmed milk. Standardised lots of milk were preheated to 60°C, homogenized at a pressure of 140.7 kg/cm\textsuperscript{2} in a single stage homogenizer, preheated to 85°C for 15 min and cooled to 40°C. Three equally divided lots of milk solids were inoculated with three strains at the rate of 2 per cent, filled in polysterene cups having lids and then incubated at 40± 1 °C. For assessing microbial changes during incubation a set of cups from each lot of milk were drawn at 0, 2, 4, and 6 hours period, during ambient temperature of storage (37±1°C) samples were drawn at 0, 12, 24, and 48 hours of storage and in case of refrigerated storage (5-7°C) at an interval of 0, 6, 12, and 18 days of storage and examined for the above said parameters.

T\textsubscript{3} level of total solids gave significant (P<0.05) result than other level of total solids with respect to change in titratable acidity, extent of lactose degradation, change in lactic count and β- galactosidase content during incubation with all the three strains. C2 and C3 showed higher acid production up to 4 hours than C1 and dahi with desired level of titratable acidity can be produced with these two cultures within 4.5 hours of incubation. C2 gave highest β- galactosidase activity followed by C3 and it was lowest with C1 culture.

During ambient and refrigerated temperature storage, T3 showed significant (P<0.05) with respect to change in titratable acidity, change in lactic count, extent of lactose degradation and β- galactosidase activity. Dahi showed a shelf-life of 12 days at refrigerated temperature and only 24 hours at ambient temperature based on the various Organoleptic and microbiological examination.
SQM-12 Effect of Fat/Protein Ratio of Cow Milk Adjusted to Preceded Value using UF Cow Skim Milk Retentate on Sensory Quality of Rasogolla

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Five lots of Channa were prepared from cow milk after adjusting the fat/protein ratio of milk to 1.1(T2), 1.0 (T3), 0.9 (T4) and 0.8 (T5) using ultrafiltered cow skim milk retentate (total solids 22%, protein 9%). The channa obtained using the above treatments were used as a base material for rasogolla making. The sensory profile of channa using these treatments were compared with control (i.e. rasogolla made from cow milk channa fat/protein = 1.4, T1). In this study four replications were taken.

The study indicated that from amongst all the samples the total score of T2 was the highest (90.34) followed by T1, T3, T4 and T5. T2 had the desirable soft and spongy characteristics while control showed a very sort and broken surface and slightly flat in shape. As the fat/protein ratio decreases, the softness of rasogolla decreased and chewiness and hardness increased as indicated by the judges giving a lower body and texture score and comments. There was no significant effect on other sensory attributes viz. smell, appearance and colour of rasogolla, but significant effect on body and texture.

The study indicated that good quality rasogolla can be prepared by using cow milk by adjusting the fat/protein ration to 1.1 using UF cow skim milk retentate.

SQM-13 Effect of Fat/Protein Ratio of Cow Milk Adjusted to Preceded Value using UF Cow Skim Milk Retentate on Yield and Composition of Rasogolla

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Five lots of Channa were prepared from cow milk after adjusting the fat/protein ratio of milk to 1.1(T2), 1.0 (T3), 0.9 (T4) and 0.8 (T5) using ultrafiltered cow skim milk retentate (total solids 22%, protein 9%). This channa was used as a base material for preparing rasogolla. The yield and composition of rasogolla using these treatments were compared with control (i.e. rasogolla made from cow milk channa fat/protein = 1.4, T1). In this study four replications were taken.

The study indicated that there was a significant increase in yield of rasogolla from T2 (472g/100g channa) compared to other treatments including control i.e. T1 (369g/100 g), T3, 380 g/100g), T4(363 g/100g) and T5(358g/100g). There was no significant difference in the total solids, sugar and ash content between various treatments. However, there was a significant increase in protein content from T1 (5.47%) to T5 (6.79%) and a significant decrease in fat content from T1 (3.73%) to T5 (2.93%).

The study indicated that rasogolla prepared from cow milk channa (adjusted to fat/protein ratio 1.1) had the higher yield and good quality compared to other treatments studied.
SQM-14 Quality Aspects of Yoghurt and Dahi Manufacture using Soymilk and Milk Blends

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The investigation was undertaken to study the rate of acid development and physico-chemical and sensory characteristics of yoghurt and dahi prepared from soymilk and milk blends supplemented with sugar or skim milk powder. Milk was replaced with soymilk at 25, 50 and 75 per cent levels and supplemented with sugar (1.5 to 6.0 per cent) or skim milk powder (1 to 3 per cent). The blends were inoculated with yoghurt or dahi culture @ 2 per cent. The effect of incorporation of soymilk, sugar and skim milk powder was found to be significant on the rate of acid development, viscosity, syneresis as well as on appearance, body and texture, flavour and overall acceptability scores. The rate of acid development in blends dwindled with augmented levels of soymilk and improved with increase in the amount of sugar or skim milk powder. The viscosity of yoghurt and dahi increased with the addition of soymilk, sugar and skim milk powder while the syneresis declined. The scores for all the sensory attributes lowered with increased amounts of soymilk. However, the scores improved with the addition of sugar and skim milk powder. The yoghurt sample containing 25 per cent soymilk, 3 per cent sugar and 3 per cent skim milk powder and dahi having 50 per cent soymilk, 3 per cent sugar and 2 per cent skim milk powder were found highly acceptable.

SQM-15 Sensory Quality of Rasogolia Made from Goat Milk Chhana using Different Coagulants

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Rasogolla was made from chhana obtained with 2% concentration of citric acid and lactic acid and the sour whey with the acidity of 1.2% at 80°C temperature of coagulation. Rasogolla prepared from Barbari goat milk chhana elicited higher score (4.62) for consistency than from Jamunapari goat milk chhana (4.05). Among the coagulants higher score (4.81) for consistency was observed with lactic acid whereas citric acid produced rasogolla with a lower score (3.88). The sour whey gave intermediate values for both breeds. Lactic acid resulted a spongy rasogolla than the sour whey or citric Acid. A significant effect (P<0.01) of breed and coagulants on the consistency of rasogolla was observed. Citric acid and sour whey resulted a smooth texture of the product while lactic acid produced a slightly grainy product. The breed of goat had little effect on texture of rasogolla. Rasogolla prepared from Barbari milk chhana obtained a higher score for juiciness (4.87) than from Jamunapari milk chhana( 4.17). Lactic acid produced rasogolla with slightly better juiciness while citric acid and whey resulted in almost similar score for it. Statistically the effect between breeds was significant (P<0.01 while it was insignificant in case of coagulants used for preparation of rasogolla. A slightly better score for flavour was obtained in case of Barbari milk rasogolla (4.94) than for Jamunapari milk rasogolla (4.84). Among the coagulants, lactic acid imparted a better flavour to the product than the sour whey and citric acid. Overall acceptability for rasogolla prepared from both Jamunapari and Barbari milk chhana was almost the same. The rasogolla made from chhana using lactic acid as coagulant obtained a higher score and preferred by judges.
SQM-16  Yield and Quality of Mozzarella Cheese Made from Jamunapari Goat Milk

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Jamunapari goat milk was collected from Central Institute for Research on Goats, Makhdoom, Farah, Mathura (UP) to standardize the method of preparation of Mozzarella cheese. Milk was standardized to 3% fat and pasteurized by holding method. Calcium chloride @ 0.02% and starter culture (S. thermophilus and L. bulgaricus) at the rate of 2% was added. Meito Rennet was added at the rate of 1.0g/100 liters of milk and content were kept for 45 minutes. After setting the curd was cut and left undisturbed for 10 minutes. The curd was then heated gradually with continuous stirring till the curd became slightly hard. Curd was cooked till firm. The whey was drained off completely, after which the curd was immersed in hot water at 83-84°C. The curd was kneaded, stretched and moulded for proper body and texture development. The hot plastic mass was moulded into ball and then immersed in brine solution (20% v/w) at 4±1°C for 3 hours. The product had yield (%), pH, percent titratable acidity, stretchability 13.37±0.21, 5.65±0.03, 0.415±0.016 and 2.51±0.17, respectively. The product was rated good for appearance (2.09±0.08) body and texture (3.30±0.09) and flavour (6.12±0.26) when evaluated on 18 point scale (Max. Score for appearance = 3, body and texture = 5 and flavour = 10). The results of the study, therefore, suggested that a good quality Mozzarella cheese could be prepared from Jamunapari goat milk.

SQM-17  Physico Chemical Quality of Table Butter marketed in Agra City

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The present project was undertaken to assess the quality of table butter sold by different dairies in Agra city. Different samples (thirty from organized sector and forty from unorganized sector) were collected and analyzed for various physical and chemical characteristics. To make a comprehensive interpretation and illustration of the results control butter sample was considered as a standard. Physical characteristics viz. appearance, flavour, body and texture and chemical characteristics as laid down under PFA act viz. moisture, fat, salt and curd were selected as criteria for measurement of quality of table butter. The ANOVA of the observed data suggested that the difference in all the parameters was statistically significant (P<0.05). Based on the findings of the present investigation it was concluded that the physical and chemical attributes were within the limits of legal standards. Most of the parameters tested here were upto the mark as per the standards laid down by PFA acts. On comparison among the dairies it was concurred that the organized sector supplied better quality products.
Probiotic Acidophilus Milk: An Innovative Approach in Health Management of Tribal Kids

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Probiotic Acidophilus Milk (PAM) was prepared from buffalo milk by inoculating a human strain with proven probiotic Lactobacillus acidophilus. The study was planned to investigate the implantation ability of the culture in the gastrointestinal tracts tribal children (TC) of 2-5 years. Before recruitment and enrollment into the study, parents/guardians of the TC were provided with a full explanation of the study and a formal informed consent sought and recorded. The Local Human Ethics Committee approved the study. One hundred and thirty five TC of three age groups (viz. two-three, three-four and four-five years) were randomly selected and allocated in three groups. Volunteers from each of the age groups were in three equal sub-groups comprising of fifteen TC. A control group of the volunteers received plain Dahi (0.60% LA) containing 10^7 cfu of mixed culture of mesophilic lactococci/g @100 g/volunteer/day and the test group received 100 g freshly prepared Probiotic Acidophilus Milk (PAM) containing 10^7 cfu/g of L. acidophilus-LBKV, while the blank control group volunteers received plain buffalo milk @ 100 ml/volunteer/day. Before commencing the feeding trial (FT) faecal matter was analyzed twice for its microbial content (Lactobacilli, Propionibacteria, Bifidobacteria and Lactococci as a group of friendly organisms and Clostridium, Clostridia, Staphylococcus and Enterococci as harmful organisms). It was analyzed at an interval of 15 days during three month FT and after its termination. A follow up was conducted for one year. No any restriction on the dietary habits was exerted but the kids were encouraged not to take any medication. A wide variation in the initial microbial counts in the faecal matter was observed. Feeding of PAM resulted in many fold increases in friendly types and very sharp decline in the harmful organisms after fifteen days of commencing FT in test group TC. The trend was continued further to lead almost negligible counts of putrefactive groups and huge increases in the friendly organisms in the test group as against the control and blank control groups. The highly significant increases in friendly types and a sharp decline in the harmful organisms even after terminating the FT is an indication of the positive implantation ability of human strain of L. acidophilus in the gastrointestinal tracts (GIT) of the subjects. It is concluded that the feeding of PAM shall be effective in combating the problem of heavy morbidity (due to GIT and related ailments) in this most neglected section of the society. Thus, the incorporation of PAM in health management of tribal kids could prove to be an important value addition.
**SQM-19** Consumer Acceptance of Ready-to-Reconstitute *Basundi* Mix

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This study aimed at evaluating the response of consumers of traditional *Basundi* towards a newly developed Ready-to-Reconstitute *Basundi* mix (RTS-BM; Proximate composition: 4.15% moisture, 18.94% fat, 21.21% protein, 28.94% lactose, 22.32% sucrose and 4.45% ash content). A total of 145 respondents from Nanded, Parbhani, Hingoli, Akola, Yeotmal, Washim and Ahmednagar districts of Maharashtra participated in the study. Consumers’ liking for traditional *Basundi*, the extent of liking for RTS-BM, their demographic characteristics and willingness to purchase RTS-BM were ascertained. The ranking decision was recorded using a 5-point scale (1-not liked; 5-liked extremely). The average consumer response for RTS-BM was between ‘very good’ and ‘excellent’; numerically, it was 4.12. A sizeable number of consumers (79%) rated the product as ‘very good’ or better indicating a high acceptability of the new RTS-BM. Most of the respondents (97%) expressed their willingness to buy this product as and when it would be available in the market. The result of this study provided valuable information on consumers’ response to RTS-BM, which would be useful for test marketing and commercial launch of the product.

**SQM-20** Value Addition of Milk-chocolate using Inulin and Encapsulated *Lactobacillus Casei* NCDC-298

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The use of products containing probiotics is on the rise for positive effect on health. The efficacy of probiotics depends on the dose and viability throughout the product’s shelf-life and during gastrointestinal tract (GIT) transit. Microencapsulation of probiotics in hydrocolloid beads has been tested for improving their viability. The expected benefits include an improved survival during the passage of probiotics through the upper intestinal tract when probiotics and prebiotics are used in combination (i.e. Synbiotics). Recent trends are towards the diversification of probiotic foods to non-fermented and heat-treated products, however, live cultures are destroyed during heat treatment. Milk chocolate having inherent nutritional and functional attributes is belonging to non-fermented heat-treated food category and is widely accepted to all age groups; hence, having a gigantic market in world. Therefore, an attempt has been under taken in improving functional property of milk-chocolate by incorporating inulin (prebiotic) and alginate encapsulated *L. casei* NCDC 298 (probiotic). The quality of the milk-chocolate during storage and efficacy in delivering the live lactobacilli the intestinal microenvironment of mice were studied. After 30 days of storage at room temperature, the lactobacilli counts were decreased by approximately 3 and 2 log cycles from an initial level of ~8 log cfu/ g in milk chocolate with free and encapsulated lactobacilli, respectively; however, at refrigeration temperature the viability of free as well as encapsulated lactobacilli was unchanged in chocolate till 60 days. Sensory panelists liked the chocolate with encapsulated lactobacilli. Supplementation of milk chocolate with inulin (5%) and encapsulated lactobacilli increased the fecal lactobacilli, decreased coliforms and β-glucuronidase activity. Thus, a good quality milk-chocolate could be manufactured by incorporating alginate encapsulated lactobacilli, which may provide protection to bacteria during storage and gastrointestinal transient. Further, *in-vivo* studies in human subjects will explore the possibilities of milk-chocolate in delivering of live probiotics.
Study of Mathematical Models Applied to Sorption Isotherms Data of Ready-to-use Basundi Mix

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Moisture isotherms are extremely valuable for optimizing processing conditions, product formulation and prediction of shelf life. In order to evaluate the moisture desorption properties of the product, the desorption isotherms of ready-to-use Basundi mix, a convenience traditional Indian dairy product, were established. The temperatures selected for the study were 5, 25 and 45°C. The desorption curves exhibited a sigmoid shape corresponding to type II, typical of many foods. There was generally a negative temperature effect on equilibrium moisture content at low a_w, but curves at 25°C and 45°C showed inversion above water activity of 0.7 implying a higher equilibrium moisture content at higher temperature due to the presence of sugar. Out of five mathematical models employed, modified Mizrahi (percent RMS; 3.06, 4.51 and 5.65) followed by GAB (percent RMS; 5.88, 5.02 and 6.06) were found to be the best-fitted at all the three temperatures i.e. 5, 25 and 45°C. Monolayer moisture for ready-to-use Basundi mix was 3.58, 3.28 and 2.11 at 5, 25 and 45°C, respectively. Besides monolayer moisture, properties of sorbed water and isosteric heat of sorption were also obtained. Results implied that the product was having potential for longer shelf life.

Inhibitory Effect of Bacteriocins from Lactobacillus Acidophilus 291 on Listeria Monocytogenes in Buffalo Meat

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Listeria monocytogenes have emerged as important pathogens of meat borne zoonotic disease. Inadequacy of conventional meat preservation methods for its effectiveness in meat has made the basis of investigating inhibitory effect of bacteriocins from Lactobacillus acidophilus 291 and commercial nisin of food grade (Nisaplin™) added to buffalo meat stored at 4 ± 1°C over a period of 21 days. The inhibitory effect of bacteriocin from Lactobacillus acidophilus 291 on Listeria monocytogenes at different concentrations (500, 1000 and 5000 AU/ml) was investigated in buffalo meat stored at 4 ± 1°C over a period of 21 days. And also the effect of three concentrations (400, 800 and 1200 IU/ml) of commercial nisin (Nisaplin™) was studied in producing inhibitory effect on Listeria monocytogenes in buffalo meat stored at 4 ± 1°C over a period of 21 days and this experiment was done to find out the superiority of bacteriocins from Lactobacillus acidophilus 291 and nisin. Bacteriocin producing L. acidophilus 291 was propagated in Lactobacillus MRS broth with pH control of 6.0 and the activity was detected with Lactobacillus delbrueckii subsp. lactis 310 as the sensitive indicator organism. The bacteriocins assay revealed a bacteriocin activity of 25,600 AU/ml. The experiment result reveals that bacteriocin concentrations e” 1000 AU/ml were found to be effective against L. monocytogenes. The effect of commercial nisin (Nisaplin™) was studied in producing inhibitory effect on L. monocytogenes and all the concentrations of nisin used in the experiment were found to be effective in inhibiting L. monocytogenes. On comparing inhibitory effects produced by bacteriocin from L. acidophilus 291 and commercial nisin (Nisaplin™) on L. monocytogenes was inhibited both by bacteriocin and nisin. But nisin has shown better inhibitory effect than bacteriocin from L. acidophilus 291 which can be attributed to the purity of nisin.
Inhibitory Effect of Bacteriocins from *Lactobacillus Acidophilus* 291 on Verotoxic *Escherichia Coli* in Buffalo Meat

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Verocytotoxin producing *Escherichia coli* (VTEC) have emerged as important pathogen of meat borne zoonotic disease. Inadequacy of conventional meat preservation methods for its effectiveness in meat has made the basis of investigating inhibitory effect of bacteriocins from *Lactobacillus acidophilus* 291 and commercial nisin of food grade (Nisaplin™) added to buffalo meat stored at 4 ± 1°C over a period of 21 days. The inhibitory effect of bacteriocin from *Lactobacillus acidophilus* 291 on Verotoxic *Escherichia coli* at different concentrations (500, 1000 and 5000 AU/ml) was investigated in buffalo meat stored at 4 ± 1°C over a period of 21 days. And also the effect of three concentrations (400, 800 and 1200 IU/ml) of commercial nisin (Nisaplin™) was studied in producing inhibitory effect on Verotoxie *E. coli* in buffalo meat stored at 4 ± 1°C over a period of 21 days and this experiment was done to find out the superiority of bacteriocins from *L. acidophilus* 291 and nisin. Bacteriocin producing *L. acidophilus* 291 was propagated in Lactobacillus MRS broth with pH control of 6.0 and the activity was detected with *Lactobacillus delbruckei* subsp. *lactis* 310 as the sensitive indicator organism. The bacteriocins assay revealed a bacteriocin activity of 25,600 AU/ml. The experiment result reveals that bacteriocin concentrations e” 5000 AU/ml were found to be effective against Verotoxic *E. coli*. The effect of commercial nisin (Nisaplin™) was studied in producing inhibitory effect on Verotoxic *E. coli* and it did not exert any significant inhibitory effect on Verotoxic *E. coli*. On comparing inhibitory effects produced by bacteriocin from *L. acidophilus* 291 and commercial nisin (Nisaplin™) on Verotoxic *E. coli*. Verotoxic *E.coli* was inhibited only by bacteriocin from *L. acidophilus* 291 but not by nisin.

A Study on Consumers’ Response to Ready-to-reconstitute Ras Malai Mix


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A new shelf stable product formulation, ready-to-reconstitute *Ras Malai* mix, developed by employing osmo-air drying process was subjected to consumers’ response survey. The product comprised of two components namely instant syrup-mix powder, representing the liquid fraction of rasamalai and dehydrated patties representing the solid fraction. The product in packaged form along with the instruction for reconstitution was offered to the consumers. A total of 113 respondents participated in the study. Consumers were asked to evaluate the product using a 5-point scale (1-not liked; 5-liked extremely). Their opinion was also sought for willingness to purchase the new formulation. More than 80% of the consumers rated the product as ‘very good’ or even better. The average consumer ranking for the product was more than 4.0. Consumers were also segregated according to age and sex to evaluate demographic pattern for their responses. More than 90% of the respondents expressed their willingness to buy this product if the product was offered for sale. The information generated is valuable for test marketing and commercial launch of the product.
SQM-25 Formation of Oligosaccharides in Milk Fermented with *Lactobacillus Casei*

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Functional foods are bioactive nutritional supplements which promote health beyond providing nutrition. The exploring area of functional foods shows considerable promise to expand dairy industry in new arenas. Dairy food fits naturally with probiotics which have a beneficial effect on the host by altering gastrointestinal flora. In contrast, prebiotics are defined as nondigestible food ingredients that beneficially affect the host by selectively stimulating the growth and/or activity of beneficial bacteria in colon. Combination of probiotics and prebiotics are known as synbiotics. Several recent reviews summarised the available experimental evidences for the health beneficial effects of synbiotics. Milk fermented with probiotics and production of prebiotics during fermentation process presents the opportunity to create value-added synbiotic products. In the present study the milk fermented with *Lactobacillus casei* 19 was evaluated for changes in pH, titratable acidity, viability, α-Galactosidase activity and oligosaccharides production during fermentation process and 8 d storage at 7°C. Milk inoculated with 1% *Lb. casei* and incubated for approximately 17-18 hrs at 37°C and then samples were transferred to refrigerator at 7°C and stored for 8 days. After incubation (0 day) the pH and titratable acidity were approximately 4.8 and 1.01, respectively. During storage, the pH decreased and titratable acidity increased significantly (p<0.05). The viability of lactobacilli and α-galactosidase activity increased till 4 days of storage and thereafter showed decrease. But lactobacilli viability was remained at >10⁷ cfu/ml on 8 days of storage. The lactose concentration decreased, whereas glucose, galactose significantly increased during fermentation and storage period. Oligosaccharide production increased due to fermentation increased and remained stable during 8 days of storage. On the basis of results of present study it is concluded that the milk fermented with *Lactobacillus casei* 19 can be included in synbiotic preparations of dairy foods.

SQM-26 Effect of Sugar Diffusion on Physical and Textural Properties of Carrot Slices

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Carrots are high moisture foods and therefore perishable. It is rich in Vitamin-A, Fibers, b-carotene and minerals. Osmotic dehydration with sugar is one of the prevalent processing means to preserve carrots for later use in a number of recipes. In the present study, carrot pieces i.e. 26 mm in diameter and 15 mm in length respectively were treated with sugar as osmotic agent. This experiment was carried out at 3 different temperatures: 35 °C, 45 °C and 55 °C with two different sugar concentration: 55 and 65 ° Brix respectively for 12 hours continuously. During this process while the moisture content in the product decreased, the total sugar and total solids increased thereby leading to lowering of water activity. Some variation in color characteristics (L*, a* and b*) was also noted. With the increase in temperature of diffusion, the rate of sugar diffusion increased and there was simultaneous increase in the hardness of carrot pieces as determined by texture analyzer. The finished product was intermediate moisture product, which could be used for further processing.
SQM-27  Quality of Processed Cheese Spreads Made using Different Forms of Buttermilk Solids

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Processed cheese spread (PCS) were prepared using different forms of buttermilk solids viz. fresh sweet cream buttermilk (SCBM) to replace part of water used to standardize moisture contents of PCS; concentrated buttermilk (CSCBM) and concentrated fermented buttermilk (CFBM) at 20 % and buttermilk chakka (BMCH) at 25 % by weight of cheese solids in the blend to decide the most appropriate form of addition. PCS were prepared using young (30 %, 3 to 3.5 m old) and ripened (70 %, 4 to 5 month old) cheese and tri sodium citrate and di-sodium phosphate in 2:1 proportion and at 2.5 % @ by weight. Experimental samples contained buttermilk solids as above. The form of buttermilk solids and its level of incorporation significantly affected acidity, pH, soluble nitrogen and TVFA content of PCS; however control and SCBM added samples were alike in these attributes. Sample containing BMCH had highest soluble nitrogen and TVFA contents followed by CFBM and CSCBM. Addition of buttermilk solids caused significant changes in penetration value, meltability and fat leakage. All samples except SCBM added had identical penetration value. The meltability was significantly decreased in samples with fermented forms (CFBM and BMCH); however, samples with non-fermented forms had higher meltability. All the experimental PCS samples had lower fat leakage values. Incorporation of buttermilk solids in various forms improved sensory properties of PCS imparting glossy shiny look, better flavour and spreadability. Addition of buttermilk solids in any form could be used, however, maximum savings in blend cost was with BMCH.

SQM-28  Antimold Activity of Lactoferrin Isolated from Cow and Buffalo Milk

Shilpa Vij, R.K. Malik, Bimlesh Mann and Rajesh Bajaj

The study was undertaken to isolate the cow and buffalo lactoferrin and to determine their antifungal activity against standard NCDC mold cultures. Lactoferrin was isolated from buffalo and cow colostrums using weakly acidic cation exchanger CM - Sephadex C-50 using linear salt gradient and purified on Gel filtration over Sephadex G-200 column. Purity of lactoferrin assessed by SDS-PAGE showed single band of 80 K Dal. Anti-mold activity of buffalo and cow lactoferrin was studied against four test mold strains (Aspergillus niger, Rhizopus oryzae, Penicillium roquefortii and P.camembertii) procured from NCDC. The lowest inhibitory conc. of buffalo and cow lactoferrin for mold cultures was in the range of 25-75 and 25-125 µg/ml respectively. The fungicidal effect of buffalo and cow lactoferrin was detected against 4 test mold strains at 30°C in buffer

- Spot assay method and well assay method also showed zone of inhibition by lactoferrin against mold culture. Microscopic examination showed that mold sporulation was inhibited in the samples treated with Lactoferrin.

SQM-29  Antimicrobial Activity of Buffalo Casein Derived Peptides

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Milk proteins are important source of bioactive peptides which are encrypted within the sequence of precursor protein and released during hydrolysis induced by digestive or microbial enzymes. Casein represents a heterogeneous group of milk proteins, with a potential
source of bioactive peptides. So far studies on antimicrobial peptides derived from casein of bovine and rabbit origin have been reported. In the present study, antimicrobial peptides derived from buffalo casein have been presented. Buffalo casein was separated from pooled milk at pH 4.6 using HCl, subjected to hydrolysis by chymosin at pH 6.4 (E: S 1: 17000), incubated at 30°C for 30min. The enzyme was inactivated by raising the temperature to 80°C for 10 min and hydrolysed casein was precipitated with 2% TCA followed by 12 % TCA. The precipitates were dissolved by raising pH to 7.2, dialysed and freeze dried. The peptide fraction resulted in antimicrobial activity against *Escherichia coli* NCDC134, *B. cereus* and *Kluveromyces*. At 1000 µg/ml concentration of peptide, a 50% reduction of viable cell count of *Escherichia coli* was observed while in case of *B. cereus* the reduction of total count was from 140 x 10^3 to 40 x 10^3 as concentration increased to 1000 µg/ml. There was strong effect of peptide against yeast with 50% reduction at 250 µg/ml concentration.

**SQM-30** Use of Solar Energy for Pasteurization of Milk

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Raw milk (32°C) was pasteurized using solar water heating system (Cap. 5000 LPD at 80°C, 62 Nos. of standard size solar panels) and a plate heat exchanger (PHE) (Cap. 750 LPH). The milk from PHE at 60°C (Outlet temp. of hot water 66°C) was collected in a jacketed tank and re-passed through PHE, resulting in final temperature 68°C (Outlet temp. of hot water 73°C). It was held at this temperature for 30 min. in the jacketed tank and cooled to < 5°C. It showed alkaline phosphatase negative test. The pasteurized milk was stored at room and refrigerator temperatures. It spoiled after 8 and 47 hours respectively as judged on the basis of increase in acidity and COB test. MBR time improved from 50 min (raw milk) to 300 min (heated milk). Pasteurized milk was analyzed for various counts such as standard plate, psychrotrophic, thermophilic, thermoduric, spore formers and coliforms. The results for the same were satisfactory. SPC resulted in approximately more than one log cycle reduction whereas coliforms were absent. It is concluded that (1) with solar water heating system as above one can pasteurize approximately 3500 liters milk per day, (2) in cloudy season booster-heating system may be employed to gain the same capacity, (3) the system can be employed at chilling centers to improve the milk quality and (4) use of heat regeneration sections in PHE could result in better capacity utilization.

**ECQ-1** Dairying for Promoting Entrepreneurship in Rural India

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To ensure employment and livelihood security to the rural masses, agriculture and its allied aspects need much focused attention. Animal husbandry and dairying is an important component of micro-enterprise promotion in rural India. In developing Country like India where still almost one fourth of its gross domestics product (GDP) is obtained from agriculture, the income obtained from livestock rearing and dairying alone contributes to 9% of the GDP. All round development of this sector demands strong infrastructural support for creating new business opportunities and entrepreneurship in the areas of production, procurement, transportation, processing, value addition and finally marketing of dairy and other livestock products. The benefit of entrepreneurship development in livestock and dairy sector should ideally be with the dairy farmers and to do so the empowering process have to be in place and human resource development in this sector should be focus of the dairy extension system.
ECQ-2  Value Added Dairy Products: Strategic Interventions for Human Resource Development

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The food processing and value addition are acquiring a prominent and priority status in the country’s growth plans. The level of processing varies from sector to sector. For the dairy sector the level of processing is about 37% – 15% under the organized sector and 22% under unorganized sector. The share of organised industry is expected to rise rapidly-especially in the urban regions. The rise in the market for dairy products is likely to witness the fastest growth at over 20-30% per annum. There is a need to have a well designed Human Resource Development (HRD) Plan to meet the emerging challenges in the sector. The Food Safety and Standards Bill, 2005, now before a Parliamentary Standing Committee and the new draft processing policy make a case for strong human resource base, which is an important link in the food value chain.

The current HRD profile for the dairy science is much skewed. The total annual intake capacity is about 1140 comprising 405 at Post Graduate level, 590 at Graduate level and 145 at Diploma level. The human capital base is quite weak and narrow at lower level. The pedagogy does not exist for: (a) farmers and small entrepreneurs, (b) skill up-gradation of workers, (c) development of technicians, (d) entrepreneurial bias, (e) continuing Education programmers for technical and management personnel and (f) emerging vocations- value added indigenous products, food safety and standards, marketing and WTO implications, etc. Strategic HRD interventions are required keeping in view the share of unorganized sector and the anticipated growth rate. There is a need to develop a training model for the workers of the unorganized sector as well as organized sector which ensures quality production of value added products and facilitates their mobility towards entrepreneurial and formal education system. The competency based qualification framework can provide a mechanism for linking informal and formal systems, whereas the open and distance learning provides a platform for training the stakeholders at their doorstep.

ECQ-3  Emergence of Value Added Dairy Products in Indian Export Basket

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The export of dairy products from India has increased at an annual rate of 22.47% from US$ 1.34 million in 1990-91 to 20.39 million in 2003-04. Asian countries are the major destination, accounting for 80% share in our dairy product exports. The Skimmed Milk Powder, Ghee and sweetened milk in powder, granular or other solid forms of fat content >1.5% were the three main dairy products exported to Asian markets in 1991-93, with 85% share in value of dairy exports. With the changing demand pattern for dairy products in Asian destinations notable changes have occurred in the export portfolio of value added dairy products. In general, low fat based products have begun to replace the exports of high fat based products. Milk food for babies (fat <1.5%) and other milk powder (fat<1.5%) are the two regularly exported products that have picked up substantially in recent years. Products consisting of natural milk constituents and Cheese (other than fresh, powdered, processed or blue-veined cheese) are our new products finding markets in Asia. The average export value of these products during 2001to 2004 was quite high at US$ 300 and US$ 183 thousands, respectively. After 2001, a few other products like unsweetened condensed milk, powdered cheese and fermented dairy products have also emerged in India’s export basket after 2001. In the Indian sub-continent there is demand for value added products like SMP, WMP, butter, ghee, milk food for babies and paneer. The demand for ghee and paneer is also high in Gulf countries. Important markets for whey based, low fat and fermented dairy products are South and East Asian countries.
DAIRY TECHNOLOGY SOCIETY OF INDIA

GENESIS

Food Processing is a key industrial segment for India, involving 6 per cent of total industrial investment, 13 per cent of exports and employing 18 per cent of India’s industrial labour force. The significance of dairying as a component of the food processing sector and an enterprise in the socio-economic set up of India needs no debate. Dairy Products have occupied a special position in the Indian ethos and in India’s celebrations since Vedic times. The onus of manufacture of these dairy products in an organized manner, so that they are available to consumers in plenty, conveniently and in safe packages has been largely on the shoulder of the Indian Dairy Technologist.

India is the largest milk producing country in the world. The role of the Dairy Processors and Technologists in achieving this landmark distinction has been colossal. Although much has been done by them, they cannot rest on his laurels. There is much more for them to accomplish.

The Indian Dairy Industry can benefit by being a global runner in trade, only when its products are equivalent with those of the rest of the world in terms of price and quality. The technology to be developed would largely be market-driven. Changed life style will compel requirements for new products and for the improvement of current products. Increased desire for taste, clean environment, product safety and economy will require significant changes in the way products are produced and presented. It is evident that to ensure quality and safety in dairy products, the industry would need to maintain wholehearted commitment to quality management right from the farm to the consumer.

These changes will also place demands upon manufacturers and will enforce a positive and definite attitude and immense technological response. The burden of this response will have to be shared equally by the researcher in the laboratory and the manufacturer at the industrial level.

The need for increased co-operation, co-ordination and dialogue among all facets of the Dairy Industry now looms larger than ever. The time is ripe to recapitulate what has been done and ponder over what is to be done for the betterment of the Dairy Industry in India.

It is in this backdrop that the Dairy Technologists of this Institute have taken an initiative to bring together, under one umbrella, the individuals who hold the responsibility of ushering in a new momentum to the dairy scenario in India. The Dairy Technology Society of India is primarily a forum for scientific discussion and exchange of ideas in the field of Dairy Technology and allied sciences among all those engaged in the serious business of dairying. This vast conglomerate would encompass the Dairy Chemists, Dairy Microbiologists, Dairy Engineers, economists, publishers in the dairy field, businessmen and artisans engaged in the promotion of all dairy-based enterprise.

The Dairy Technology Society of India is determined to inculcate adequate motivation and an unquestionable resolve among the members to herald in a new era in the country’s dairy enterprise. We request all those who have a stake in the Dairy Business of the country to come forward and strengthen the Society and contribute your bit towards the nation’s prosperity.
CONSTITUTION, RULES & REGULATIONS OF THE DAIRY TECHNOLOGY SOCIETY OF INDIA

1. The name of the organization shall be ‘Dairy Technology Society of India’ (hereinafter called the Society).

2. The registered office of the Society shall be located at Dairy Technology Division of National Dairy Research Institute, Karnal – 132001 (Haryana).

3. The objectives of the Society shall be advancement of all aspects of Dairy Technology, and towards that end the Society will seek:
   3.1. To provide opportunities for the dissemination and exchange of knowledge and ideas gained from experiments and experience through meetings, conferences and seminars and for collaboration between persons and/or institutions interested in research and planning and those in production and professing.
   3.2. To practice and promote a high standard of objectivity, scientific expertise, and technical proficiency.
   3.3. To encourage and promote scientific research and development related to Dairy Technology and allied subjects.
   3.4. To promote and participate in every way in the rational and economic development of dairy industry and farming in the country in association with cooperatives, private and public organizations, national or international organizations, having similar aims and objectives.
   3.5. To assume any responsibility or functions when asked to do so on behalf of government toward the advancement of Dairy Technology and allied sciences.

4. In pursuance of these objectives, the Society shall
   4.1. Publish a journal (Indian Journal of Dairy Technology) devoted to the publication of original scientific and technical research articles, Technical and personal news items from India and abroad, information regarding the activities of the Society and its members, developmental activity and similar matters.
   4.2. Accept contribution and fees; grants from government or from other appropriate funding organizations for projects and purposes in consonance with the objectives or spirit of the Society.
   4.3. Acquire by gift, purchase, lease, loan or hire immovable or movable properties required for the purpose of the Society and deal with these properties, money and other assets to further the objectives of the Society.

5. The Society shall be non-profit making organization. It shall not give any dividend or bonus or otherwise money to its members but may pay in good faith remuneration by way of salary, fees, traveling expenses, etc, to any person employed by it to serve the organization, or to any other person including its members for any specific purpose, e.g. honorarium and traveling allowance toward the activities of the society.

Rules and Regulations

1. Membership
   1.1 Membership of the Society shall be open to:
      1.1.1. Any person who has had or is undergoing a formal training in Dairy Technology and allied sciences, or who is or was on the scientific and technical staff of an Institution or organization connected with Dairy Technology and allied sciences.
1.1.2. Any person who is interested in teaching, research or extension in Dairy Technology activities or is in a position of responsibility which could promote the future of Dairy Science and Technology.

1.1.3. Any organization connected with the area of Dairy Technology in its widest aspects, or interested in promoting the aims and objectives of the Society.

1.2 There will be five classes of membership:

1.2.1. An individual can be chosen as Life Member, Ordinary Member or Student Member.

1.2.2. An organization can be classed as a Benefactor or Sustaining Member, when applying for any of these two categories of membership, the organization will nominate one representative or the organization and in his absence another can be nominated.

1.2.3. All memberships and subscriptions will be reckoned in terms of calendar year commencing on 1st April and ending on 31st March.

1.3 The Society shall maintain a register of its members both individual and organizational, and the names of representatives nominated by the latter.

2. Qualification of the Membership, Admission Procedures and Rights of Members

2.1 Categories of Individual Membership

2.1.1. Life Member: any person interested in the activities of the Society who pays a lump sum fee of Rs.1000/- could be an ordinary Member of the Society. An Ordinary Member can adjust his subscriptions for previous two years and pay the balance of Rs.1000/- to become a life member. For this purpose, he shall make an Application on a prescribed form to Central Executive Committee (CEC). On admission, a life member will have all the rights and privileges of an ordinary member.

2.1.2. Ordinary Member: Any person fulfilling the criteria of membership is eligible to become an ordinary member of the Society and shall apply for admission on the prescribed form to CEC. The annual subscription for each calendar year or part of it will be Rs.300/-. An ordinary member will have the right to be present and to vote at all meetings of the society, to propose candidates and to stand for any elected office of the society, to contribute papers at meetings of the society, and to receive free of charge the journal of the Society which are not specially priced, as decided by the CEC.

2.1.3. Student Member: any person who is a student of bachelor’s degree or post-graduate in Dairy Technology & allied sciences, or is under training in an institution connected with Dairy Technology and allied sciences and who may be receiving a scholarship, fellowship or stipend but is not on pay rolls of his parent organization is eligible for consideration as a Student Member, and shall apply for membership on a prescribed form to the CEC. The annual membership fee for a calendar year or a part of it will be Rs.200/-. A student member will be entitled to be present at meeting of the association like a life member or ordinary member and will be entitled to receive the journal(s) of the society. He will not be eligible to vote or to stand for elected office.

2.2 Categories of Organizational Membership

2.2.1 Benefactor – Any institution paying a lump sum of Rs.25,000/- will be called a Benefactor of the Society for the period of 10 years and shall
make an application for this purpose to the CEC for consideration. A Benefactor organization will have all rights and privileges of an ordinary member and will act through its nominee.

2.2.2 Sustaining Member – Any institution contributing a sum of Rs.10,000/- annually will be called Sustaining Member of the Society and shall make an application for this purpose to the CEC for consideration. A Sustaining Member/organization will have all rights and privileges of an ordinary member and will act through its nominee.

3. Resignations, Termination and Readmission

3.1 Resignation: any member desiring to resign from Society will intimate his desire to do so to the President in writing and final decision will be taken in CEC.

3.2 Termination:

3.2.1 The CEC may terminate a member of any category whose continuation, in its opinion, is detrimental to the interest and status of the Society and the decision of the CEC in the matter shall be final.

3.2.2 An Ordinary/Student/Benefactor/Sustaining Member who is in arrears of subscription after April of the year shall be liable for termination of his membership without further intimation.

3.3 Re-admission: Readmission of a member who has resigned or whose membership has been terminated will be considered by CEC, on a written request and after payment of all outstanding dues, including a fresh membership fee wherever applicable.

4. Central Executive Committee

4.1 Functions: the Central Executive Committee of the Society will be situated at its headquarters, which will be its main administrating, policy formulating and coordinating body. The CEC will have the following powers:

4.1.1. To appoint such staff as may be necessary and to fix their emoluments, duties, terms and conditions of their service, and to terminate their service as and when required.

4.1.2. To set up committees such as Editorial Board, Publication Management Committee etc. and any other committee for various purposes as and when required.

4.1.3. To consider the nominations for admission, termination of membership, re-admission to membership and any other membership matters.

4.1.4. To buy, hire, sell or otherwise deal with any property or assets concerning the Society, enter into contracts or legal proceedings on behalf of the Society.

4.1.5. To administer the bank account and money of the Society through deposits, investments and the like, and to appoint auditors to inspect accounts of the Society.

4.1.6. To act with powers in any emergency, not withstanding any limitation in these rules, provided the spirit of constitution is maintained and that any action taken is reported to next annual general body meeting for its information and is subject to revision or alteration by the latter.

4.1.7. To delegate financial and administrative power to any office bearer or official of the Society.
4.2 Meeting of CEC: the CEC may meet once in four months; one of its meetings to be held just prior to annual general body meeting, will be held at such time and place as decided by the President. At least 15 days notice of the meeting may be given to each CEC member and such notice shall contain a statement of the main business to be transacted at the meeting.

4.3 Extra-ordinary CEC meeting: the President, either at his own discretion or on receiving the requisition signed by 5 CEC members, shall call an extra-ordinary meeting for which 7 days notice will be required.

4.4 Composition of CEC: the CEC will consist of the following:
   4.4.1. President
   4.4.2. Vice-Presidents - 2
   4.4.3. Secretary
   4.4.4. Joint Secretary
   4.4.5. Treasurer
   4.4.6. Joint Treasurer
   4.4.7. Chief Editor
   4.4.8. Editor
   4.4.9. Ten members elected from among the member of the Society.
   4.4.10. All Past-Presidents who have held office during the preceding five years and immediate past Secretary.
   4.4.11. Co-option: the CEC so formed shall have power to co-opt up to five member of the Society in the best interest of the society.

4.5 Composition of Editorial Board
   4.5.1 Chief Editor
   4.5.2. Five Members of the Board

4.6 Eligibility and mode of election: The CEC shall be elected from amongst the members of the Society who shall have paid all dues to the Society up to the date of election, barring new members in that particular year.

   4.6.1 The President, Vice President, Secretary, Chief Editor, Treasurer and 10 CEC members will be elected by the general body by postal ballot system. The Joint secretary, Joint Treasurer, Editor and 5 CEC members will be nominated by the new CEC.

   4.6.2 In making its nominations, then CEC shall ensure that the work and objectives of the Society both administrative and technical, are sought to be furthered, that the supervision of the work at headquarters is suitably provided for, and that the smooth flow of publication and the quality of the journal are ensured.

   4.6.3 The outgoing CEC will appoint a Returning Officer well in advance to conduct elections. The Returning Officer will neither himself contest for any office nor be a proposer or seconder of a candidate for any office. The Returning Officer will initiate the process of conducting elections well in advance so that based on the nominations for various posts, elections can be held, if necessary by postal ballot system. The Returning Officer shall determine the time schedule for receipt of nominations,
withdrawal, scrutiny and preparation of list of nominees for various posts. He shall arrange to communicate the same to all eligible members and take measures to conduct the elections through postal ballot system. The Returning Officer will be assisted by three-member committee nominated by CEC for counting of votes which will be in the presence of candidates or their representatives, if they so desire. The results will be communicated by the Returning Officer to the Secretary, Dairy Technology Society of India and to all the contestants.

4.7 Quorum: Six CEC members including those co-opted will constitute a quorum for the CEC. Each member will have one vote and the President will have casting vote only in the event of a tie.

4.8 Term of Office: All the office bearers will hold the particular office for two terms only and change of office will take place three months after the Biennial conference and election of new executive. All office bearers will hold office for three years after announcement of results of elections/nominations by CEC or until next general body meeting is held for such election purposes. Any vacancy arising out of resignation or otherwise will be filled by the CEC from within the members of the Society and such interim appointments will be made till the next annual general body meeting. A CEC member who wishes to resign will state so in writing to the CEC and on its acceptance by the CEC, but not till then, he shall cease to be a CEC member.

5. Powers and Functions of CEC Office Bearers

5.1 President: The President shall be the Head of the Society and all other office bearers shall work under his guidance and instructions. He shall preside over the meetings of the CEC. In his absence, one of the Vice Presidents or, failing that any other member of the CEC elected to preside over the meeting will exercise the President's powers.

5.2 Vice President: The Vice Presidents will assist the President in carrying out his functions. One of the Vice-Presidents nominated by the President shall perform his duties and exercise the powers of the President during his absence.

5.3 Secretary: The Secretary will be responsible for execution of various activities/projects on behalf of the Society and will conduct day-to-day affairs of the Society. He will manage the office of the Society. He will issue notices and convene all General Body Meetings, meetings of the CEC and any other special meeting as and when required. He will maintain Minutes Book of all such meetings. He will maintain proper and up-to-date Register of members of the Society. He will institute and defend any legal proceedings. The Secretary of the Society will execute all contracts, deeds and other instruments on behalf of the Society and members of the CEC. All these contracts shall be countersigned by the treasurer or any other member of CEC as may be named by CEC. The Secretary will also discharge all such functions and have all such powers as may be conferred under these regulations by the CEC and General Body of the Society.

5.3.1 Joint Secretary: The Joint Secretary will work to assist the Secretary and will take responsibilities of the Secretary in his absence.

5.4 Treasurer: The Treasurer shall be responsible for Society’s funds and properties and shall ensure maintenance of proper books of accounts. He will be in custody of all funds of the Society which shall be deposited in State Bank of Patiala, NDRI, Karnal Branch. He will be empowered to retain a cash imprest of not more than
Rs. 2000/- for routine day-to-day activities of the Society. The cheques would be signed by at least two office bearers of the Society such as one of the Vice Presidents and Treasurer or Secretary and Treasurer. He will issue receipts for all monies received by the Society. He will maintain a correct and detailed account of all income and expenditure of the Society and present the detailed statement of accounts and Balance Sheet duly certified by the auditors before the CEC every year and General Body Meeting every two years.

5.4.1 **Joint Treasurer**: The Joint Treasurer will assist the treasurer in keeping accounts of the Society and will take the responsibility of Treasurer in his absence.

5.5 **Chief Editor**: the Chief Editor will be the Chairman of the Editorial Board and shall exercise overall control of the quality of the publications of the Society.

5.5.1 **Editor**: The Editor will assist the chief Editor in bringing out the publications of the Society.

5.6 **Members of CEC**: Members of CEC will contribute to the effective functioning of the Society.

6. **General Body Meeting**

6.1 **General Body**: The General Body of the Society shall consist of those from the categories of individual membership and one of the nominated representatives of each from all the categories of organizational membership.

6.2 **Annual General Body Meeting** (AGBM) may be held at least once in two years. The CEC will announce the location, date and time of AGBM by giving at least two weeks notice in writing to all members of the Society.

6.3 **Business at AGBM**: Consideration of the following shall be obligatory at AGBM

6.3.1 Annual Report of the Society
6.3.2 Audited statement of annual accounts and balance sheet for the year
6.3.3 Budget for the following year
6.3.4 Election of office bearers of the Society and members of CEC in an election year
6.3.5 Post-facto approval of previous CEC proceedings
6.3.6 Approve proposals of amendments and/or new provisions for Memorandum and rules and regulations
6.3.7 Any other matter that may be brought forward with prior notice of at least 7 days.

6.4 **Extraordinary General Body Meeting**: Extraordinary General Body Meeting (EGBM) may be called if considered by the CEC to transact business of ‘special urgency’. An EGBM may also be requisitioned by a written request signed by 25 percent of the membership or 100 members whichever is less. In both cases, the purpose for which the EGBM is convened must be clearly stated, and at the EGBM itself, no business will be transacted other than that for which it has been summoned. The CEC will announce the place, date and time of the Extraordinary General Body Meeting at least two weeks in advance.

6.5 **Conduct of AGBM and EGBM**: the President shall preside over the AGBM and the EGBM. In his absence, one of the Vice-Presidents will be elected at the Meeting to preside and in the event of no Vice-President being present, any member of the CEC may be elected by the Meeting to preside. The quorum for an AGBM or EGBM shall be members, who are entitled to vote.
7. Publications

7.1 **Journal**: The Society shall bring out one periodical publication, the Indian Journal of Dairy Technology issued annually.

7.1.1 The Indian Journal of Dairy Technology shall be devoted mainly to the publication of articles of original research in science and / or technology in the field of Dairy Technology. It may also contain review articles, bibliographies pertaining to the subject, reports or the Proceedings of the Society and similar matters.

7.2 **Editorial Board**: The Chief Editor and the Editor of the Indian Journal of Dairy Technology and eight other members nominated by CEC to represent various institutions and industry together would constitute the Editorial Board. The Chief Editor shall be the Chairman of the Editorial Board.

7.2.1 The Editorial Board shall assist the chief Editor in every way in their task in publication of the Journal. Their decision regarding the acceptance or rejection of any material submitted for publication shall be final. Individual members of the Editorial Board will act when required as referees and scrutinizers of material submitted to them by the editors for review.

7.2.2 The Chief Editor, the Editor, Secretary and treasurer and five members nominated by the CEC shall constitute the Publication Management Committee which will lay down broad policy matters relating to the journal and other publications of the Society. The Chief Editor will chair the Committee. The Editorial Board will meet once a year and Publication Management Committee will decide about the implementation of the recommendations. The meeting of the Publication Management Committee should be held along with the meeting of CEC.

7.3 **Publication Procedure**: All material for publication shall be recorded. All contributions intended for publication or for reading before the Society, shall be addressed to the Chief Editor who will decide about the nature of the article. Outside expert referees may also be referred to. View of referees, when required shall be communicated to the authors.

7.3.1 All papers and other contributions submitted for publication in the journal of the Society shall become the property of the Society till they are accepted or rejected and the Society shall have the right to retain the manuscripts, illustrative drawings, photographs, etc. relating to them.

7.3.2 Once a paper has been accepted for publication, the authors shall not have the liberty to publish it elsewhere, save with the permission of the Chief Editor.

7.3.3 No paper published or under publication elsewhere will be accepted for publication in the Indian Journal of Dairy Technology.

8. Amendments to Constitution

8.1 **Procedure**: Proposals for addition to or alterations in the memorandum or the rules and regulations of the Society. Proposals will be sent to the Secretary so as to reach him at least 90 days before the AGBM. They will be considered by the CEC, who will then circulate the proposal to every member of the Society 30 days before AGBM.

8.2 **Implementation**: No amendment to or alterations in the rules and regulations of the Society shall be made except at the AGBM. The proposal will be deemed to be
approved if it has, a two-thirds majority of those present and eligible to vote at
the AGBM. Any such alterations or amendments will come into effect or operation
within one month, after its approval.

9. Recognition and Awards

9.1 **Patronship:** A person with outstanding academic or professional achievements
in Dairy Technology and/or one who has rendered signal service to the cause of
the Society may be awarded the Patronship of the Society. A Patron shall be
nominated for life and shall be entitled to have all rights and privileges of Life
Member of the Society.

9.2 **Fellowship:** A Member of the Society who has actively participated in the affairs
of the Society and who has rendered valuable services to Dairy Technology by
way of research, teaching, extension, administration and development may be
awarded fellowship of the Society. The award of fellowship bestows the privilege
of life membership.

9.3 **Special awards:** The Dairy Technology Society of India may also honour its selected
members for distinguished services or for conspicuous achievements in the field
of Dairy Technology with special awards. The Central Executive committee shall
decide the manner of establishing the awards by accepting cooperation, financial
or otherwise from individuals and/or organization.

9.4 The manner in which the awards of Patronship, Fellowship and Special Awards
will be bestowed shall be laid down by the Central Executive Committee by
appointing a board of adjudication or selection of persons for award of Patronship,
Fellowship and Special awards on each occasion.

10. Dissolution of the Society

10.1 **Dissolution:** The Society shall be dissolved, if at General Body Meeting, specially
convened for the purpose, a resolution to that effect is passed by a 3/4th majority
of not less than four-fifths of its members present, who are entitled to vote.

10.2 **Residual property:** Upon dissolution of the Society and, after payment of liabilities
and debts, if there remains any property whatsoever, the same shall not be
distributed among the members, but given or transferred to another body having
objectives similar to those of the Society, and so determined by voting on a
resolution supported by three-fifths of the members of the Society or in default
thereof, by an appropriate court of law.

**Activities of the Society**

- To develop better co-ordination and co-operation, co-ordination and continued dialogue
  between the academia and industry in the field of dairy processing
- Organization of National/ International Seminars/ Symposia/ Workshops/ Group meetings
  on innovative ideas in the area of Dairy Processing
- To create general awareness about the importance of cleanliness and hygiene at the
  grass-route levels of milk production, processing and distribution so as to ensure public
  safety and health
- Dissemination of knowledge about latest developments in dairy processing through
  newsletters, journals and other publications
- Acting as a liaison between the decision makers of the country and those responsible for
  the enforcement of the food laws so that a more systematic and scientific approach to
  achieving high quality standards in dairy products