Directorarte of Entrepreneurship, KVASU,
Dept. of Dairy Science, CVAS, Mannuthy
& MANAGE, Hyderabad

"Refresher Course on Quality Challenges in Dairy Sector"

for Dairy Farm Instructors

COMPENDIUM OF LECTURES

Editorial board

Dr. M.K. Narayanan • Dr. Shahaji Phand • Dr. C. T. Sathian
Dr. R. Geetha • Dr. K. Radha • Dr. A. Irshad

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Directorate of Entrepreneurship, KVASU,
Department of Dairy Science, CVAS, Mannuthy
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Refresher Course on

Quality Challenges In Dairy Sector For Dairy Farm Instructors

Programme Coordination

Department of Dairy Science, CVAS, Mannuthy
Kerala Veterinary and Animal Sciences University,

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Quality Challenges in Dairy Sector for Dairy Farm Instructors

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This e-book is a compilation of resource text obtained from various subject experts of Directorate of Entrepreunership, KVASU - Dept. of Dairy Science, CVAS, Mannuthy, Kerala & MANAGE, Hyderabad, Telangana on **Refresher Course on Quality Challenges in Dairy Sector for Dairy Farm Instructors**. This e-book is designed to educate extension workers, students, and research scholars, academicians related to Dairy Science and Animal Husbandry about Quality Challenges in Dairy Sector. The publisher or the editors do not assume any liability for any damage or injury to persons or property from any use of methods, instructions, or ideas contained in the e-book. No part of this publication may be reproduced or transmitted without prior permission of the publisher/editor/authors. Publisher and editors are not responsible for any error or omissions regarding the materials in this e-book.

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MESSAGE

National Institute of Agricultural Extension Management (MANAGE), Hyderabad is an autonomous organization under the Ministry of Agriculture & Farmers Welfare, Government of India. The policies of liberalization and globalization of the economy and the level of agricultural technology becoming more sophisticated and complex, calls for major initiatives towards reorientation and modernization of the agricultural extension system. Effective ways of managing the extension system needed to be evolved and extension organizations enabled to transform the existing set up through professional guidance and training of critical manpower. MANAGE is the response to this imperative need. Agricultural extension to be effective, demands sound technological knowledge to the extension functionaries and therefore MANAGE has focused on training program on technological aspect in collaboration with ICAR institutions and state agriculture/veterinary universities, having expertise and facilities to organize technical training program for extension functionaries of state department.

In the ancient times milk was considered commodity for charity rather than marketable commodity. There has been a phenomenal change and presently the milk became highest value commodity among all agricultural commodities. Dairying has been considered as one of the activities aimed at alleviating the poverty and unemployment especially in the rural areas in the rain-fed and drought-prone regions. Dairy farming was once a subsidiary occupation now transforming to industry. The country stands as a world's largest milk producer, accounting more than 13% of world's total milk production. The per capita availability of milk crossed the recommended level of ICMR. However, the quality of milk and milk products remain a major concern for consumer and which also limited the expert potential of milk and milk products.

It is a pleasure to note that, SAU- Kerala Veterinary and Animal Sciences University, Mannuthy, Thrissur and MANAGE, Hyderabad, Telangana is organizing a collaborative training program on "Quality Challenges in Dairy Sector for Dairy Farm Instructors" from 04-07 October, 2021 and coming up with this joint publication as e-book as immediate outcome of the training program.

I wish the program be very purposeful and meaningful to the participants and also the e-book will be useful for stakeholders across the country. I extend my best wishes for success of the program and also I wish SAU-Kerala Veterinary and Animal Sciences University, Mannuthy, Thrissur many more glorious years in service of Indian livestock sector ultimately benefitting the farmers. I would like to compliment the efforts of Dr. Shahaji Phand, Center Head-EAAS, MANAGE and Dr. M. K. Narayanan, Director of Entrepreneurship, KVASU for this valuable publication.

Dr. P. Chandra Shekara

Director General, MANAGE

MESSAGE

It is really heartening to note that the Directorate of Entrepreneurship, KVASU, Department of Dairy Science, CVAS, Mannuthy and MANAGE, Hyderabad jointly organizing ‘Refresher course on quality challenges in dairy sector for dairy farm instructors’ through online mode in this changed training scenario.

Quality monitoring in dairy industry is closely associated with the consumer health. Hence challenges faced at different levels of production, handling and processing hould be addressed properly. Role of Dairy Farm Instructors in this task is very crucial. Hence these officers are to be updated on various aspects of the subject.

I hope this refresher training would equip them to face the quality challenges in their job environment which would benefit all stakeholders in the industry. Programme would also help in sharing of knowledge and experience among all the participants that will help all of us in the perpetual journey towards improving dairy sector. My congratulations and warmest wishes for the conduct of the training programme and publication of compendium.

Prof. (Dr.) M.R. Saseendranath
Vice Chancellor

MESSAGE

Milk and milk products constitute a major part in human diet through centuries. Milk is highly nutritious and plays a major role in sustaining our young ones. Hence the quality of milk should not be compromised.

Quality should be assured throughout the process from procurement to consumption, focusing on each individual link in the chain. Each participant in the dairy supply chain is responsible in developing this quality system. Adoption of the latest protocol and equipments in quality monitoring of milk help to minimize losses; provide better quality, nutrition and more employment opportunities. Dairy farm instructors are instrumental in maintaining the quality of milk and milk products at different levels in order to ensure compliance with available rules and regulations in the State.

Updation of knowledge and skills of Dairy Farm Instructors is an essential step in dairy extension activities in the state of Kerala as they are the field level officers to address quality concerns in dairy industry. Directorate of Entrepreneurship, KVASU is extremely happy to organize the online training 'Refresher course on quality challenges in dairy sector for dairy farm instructors' in collaboration with MANAGE, Hyderabad. I also congratulate Department of Dairy Science, CVAS, Mannuthy to take up this timely training programme.

Best wishes for the training programme and participants.

Dr. M.K. Narayanan
Director of Entrepreneurship

MESSAGE

Over the span of three decades, India has become world leader in milk production. Milk production and productivity were enhanced by ensuring the availability of veterinary services, better feed resources and farmer education. Dairying became the backbone of our country sides and plays a critical role in the economic development of rural India by satisfying the needs of urban India.

Along with leap in milk production newer challenges in milk quality came into existence. Quality issues related to milking, residues, antibiotic resistance and pathogen pressures are to be addressed. Complications associated with these factors can lead to losses in milk yield and quality and ultimately affect farm productivity and human health. Dairy farm instructors can play a major role in assurance of quality at field level.

I am happy that the Directorate of Entrepreneurship, KVASU and Department of Dairy Science, CVAS, Mannuthy in collaboration with MANAGE, Hyderabad is organizing a 'Refresher course on quality challenges in dairy sector for dairy farm instructors' through online mode. I am sure that this refresher course will enable participants to make a SWOT analysis of the situation to work toward higher milk quality and production goals.

I wish all the success for this programme.

Prof. (Dr.) C. Latha
Dean

PREFACE

This e-book is an outcome of collaborative online training program on "Refresher course on quality challenges in dairy sector". This is intended to sensitize the officers of Dairy development department and field level workers to learn about various issues concerned with dairy production and processing. Furthermore, this e-book will update their knowledge regarding recent advances in tools for monitoring quality with a farm to fork approach.

Contaminants in milk originating from various sources are a matter of concern both from the standpoint of dairy industry as well as that of consumer health. Since milk constitute an important item in the diet infants and children such issues are to be considered seriously. Pathogens gaining entry into milk especially causative agents of emerging diseases like E.coli 0157:H7 pose a threat to consumers. Residues of antibiotics and other veterinary drugs in milk is a matter of concern especially with widespread incidence of antimicrobial resistance towards tuberculosis and infectious diseases as reported by World Health Organisation. Pesticide residues are also reported in milk from various geographical regions leading to cumulative toxicity in all age groups. Environmental pollutants like polychlorinated biphenyls can enter milk from different sources which may contribute to allergic reactions or even carcinogenicity. Officers of Dairy development department are the extension workers educating dairy farmers about improving productivity without compromising quality. The department is also concerned with quality assurance of milk and dairy products at processing and marketing levels. The content of training programme was designed to provide updated information towards capacity building in proposed area. Attempt has been made to cover topics on quality assurance in dairy sector ranging from clean milk production, preservation, processing and analysis.

Taken together, these experiences are enriched with technical insights and operational know-how. They provide practical evidence of actions that have proven imperative for improving quality of dairy sector in Kerala.

The valuable suggestions for future improvements are always welcome.

October, 2021 **Editors**

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QUALITY AND SAFETY OF MILK AND MILK PRODUCTS: ANOVERVIEW

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Food safety and quality assurance is an important area affecting human health. Milk being highly perishable food item maintenance of quality of milk and milk products is a challenge. Care should be exercised from production, handling, processing, storage and marketing of milk to meet this challenge. Quality assurance in dairy industry involves a set of activities strictly followed by all stakeholders from producer to consumer (farm to fork concept).
Most important focus in dairy quality management is to prevent food borne illness among consumers along with improvement in nutritional and hygienic quality of milk and milk products. Quality assurance in dairy sector involves well documented systems like Hazard Analysis and Critical Control Point (HACCP), Good Laboratory practices (GLP), Food Safety Management System (FSMS)

Food-safety hazards specific to milk and milk products
Hazard is a biological, chemical, or physical agent that is contributing likely to cause a great deal of illness or injury in the absence of its control.

Biological hazard
Milk constituents form a good medium for growth of a variety of microbes leading to spoilage of food. Generally, the microbiological quality of milk as obtained from udder during milking is normally good. But, once secreted from the udder, it can be contaminated by a variety of microorganisms from many sources (Jay et al, 2005). Some of them are spoilage causing agents while others are pathogenic. Commonly encountered pathogenic bacteria in milk are *Genus pseudomonas* (*Pseudomonas fluorescens*, *Pseudomonas fragi)*, *Genus Bacillus (Bacillus cereus), Brucella spp, Genus Staphylococcus (Staphylococcus aureus), Genus Streptococcus (Streptococcus agalactiae), Genus Mycobacterium (Mycobacterium tuberculosis)* etc. Most of them can cause severe health issues in consumers. Hence measures to prevent their multiplication in raw milk and timely destruction during processing are important.

Chemical hazard
Chemical hazards include veterinary drug residues, naturally occurring toxins, pesticide and environmental contaminants (WHO, 2009).

Chemical hazard	Main means of on farm control – preventive controls	Main means of control in processing and food handling – secondary controls
Antibiotic residues	Good animal husbandry and veterinary practices (GVPs)	Testing milk at collection point
Pesticides and Insecticide residues	Use of recommended products, safe application and observance of withdrawal period	Compliance with regulatory controls and periodic testing at milk collection point

Food additives	Use of registered substances, good manufacturing practices (GMP)	Testing of milk and dairy products

Sources: Fischer et al. (2003); FAO (2009); WHO (2009).

Physical hazard

A physical hazard can be defined as any physical material not normally found in a food which can cause illness or injury to the individuals who consume the product. It includes different types of materials often referred to as foreign materials or objects like dirt particles, hair, leaves, rubber and metal which can get into the milk during production, handling or processing (Walstra *et al*, 2006)

Hazard material	**Origin/source**	**Control measures**
Glass fragments	Bottle, jars, light fixtures and utensils	Examination of incoming materials
Insects or insect fragments and wood splinters	Fields, plant, pest-control process	Maintenance procedures designed to avoid contamination
Dirt, dust or hair	Unclean handling, storage, environment and storm	Training in good personal hygienic practices

Source: WHO (2010)

Quality assurance and certification schemes

Certification procedures and accreditation mechanisms are tools in the quality assurance system to ensure transparency and compliance with the standards and regulations that define milk and milk products. Certification procedures include inspection and certification. Inspection aims to verify and ensure that the production and handling of a product is carried out in line with certification standards. Certification, rather, confirms that those processes conform to standards. These activities could be carried out by the same certification body or an inspection body may act on its behalf. (FAO, 2003)

Effective food standards and control systems are required to integrate quality into every aspect of food production and service, to ensure the supply of hygienic, wholesome food as well as to facilitate trade within and between nations. There are four levels of standards which are well coordinated.

a. Company Standards: These are prepared by a Company for its own use. Normally, they are copies of National Standards.
b. National Standards: These are issued by the national standards body. Eg. Food Safety and Standards Authority of India (FSSAI).
c. Regional Standards: Regional groups with similar geographical, climate, etc. have legislation standardization bodies.
d. International Standards: The International Organization for Standardization (ISO) and Codex Alimentarius Commission (CAC) publish international standards.

Quality Council of India has launched two Certification schemes namely “India GHP” and “India HACCP” based on globally accepted Codex Standards for adoption by food manufacturers and supply chain operators. These schemes will help food chain related industry in our country to demonstrate compliance to global standards without having to go for costly and time consuming foreign certifications as many countries have mandated Hazard Analysis Critical Control Point (HACCP) for high risk sectors like meat, fish, dairy etc. and most developed countries have also mandated Good Hygienic Practices (GHP) across all food sectors (Ministry of Food Processing Industries, India).

Food standards and regulations in India

Voluntary product certification:

There are voluntary grading and marking schemes such as ISI mark of BIS and Agmark.BIS is the National Standard Body of India established under the BIS Act 2016 for the harmonious development of the activities of standardization, marking and quality certification of various consumer goods including food products and runs a voluntary certification scheme known as 'ISI' mark for processed foods. AGMARK is a certification mark employed on agricultural products in India, assuring that they conform to a set of standards approved by the *Directorate of Marketing and Inspection,* an attached Office of the Department of Agriculture, Cooperation and Farmers Welfare under Ministry of Agriculture & Farmers Welfare, Government of India. It provides safe reliable quality goods; minimizing health hazards to consumers; promoting exports and imports substitute; control over proliferation of varieties etc. through standardization, certification and testing.

Since the government had several regulations and laws, food industry found it cumbersome to adhere to. A need was therefore felt to integrate all such laws for regulating the quality of food. With this in view, Indian Government has passed Food Safety and Standards Act (FSSA), 2006, to bring the different pieces of legislation pertaining to food safety under one umbrella.

Food Safety and Standards Act (FSSA), 2006:

The Food Safety and Standards Authority of India was established for laying down scientific standards for food and to regulate their manufacture, storage, distribution, sale and import, to ensure availability of safe and wholesome food for human consumption. The Act has provisions for maintenance of hygienic conditions in and around manufacturing premises, assessment and management of risk factors to human health in a scientific manner, which was not specified in the PFA (Earlier regulation). The FSSA reflects the international shift in food laws, from compositional standards or vertical standards to safety or horizontal standards.

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DAIRY SECTOR - TRENDS & PROSPECTS

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The dairy sector plays an important role in nourishing the world population, producing 881 million tonnes of milk in 2019, a number that increases every year. More than 80% of the world's populations, (about 6 billion people) regularly consume liquid milk or other dairy products. Dairy farming and processing are integral to national economies and individual livelihoods. There are about 133 million dairy farms globally. Over 600 million people live on dairy farms including 80 million women, around 37 million of who head up their farms. Out of total production 9% of the global milk production is traded annually. A growing world population and changes in consumption habits continue to boost dairy demand. Demand for milk and dairy products continues to increase globally, with milk production growth expected to return close to the long-term average of slightly above 2% in 2021, supported by changes in consumption habits, an increased income per capita in developing countries and the growth of world population by 92 million people. Dairy per capita consumption reached 114.7 kg in 2019, a rise of 1.2%. Cow's milk represents 81% of total global milk production (714 million tonnes), but higher growth rates for both buffalo and goat milk indicate a growing appetite for these products. Asia is currently the world's leading region for cow's milk production at 32%.

The Indian dairy production is characterized as a low input/low output system mostly constituting small and marginal farmers and landless labourers owning less than five cows or water buffaloes. India ranks first among the world's milk producing nations since 1998 and has the largest bovine population in the world. Milk production in India during the period 1950-51 to 2019-20, has increased from 17 million tonnes to 198.40 million tonnes. Similar production situation prevalent in Kerala is also gradually shifting to farm based approach with a high percentage of exotic crossbred animals. The average milk yield per animal per day in the country for exotic, crossbred animals is 11.88 and 8.09 Kg and for indigenous, non-descript is 3.90 and 2.57 Kg per day respectively. The productivity of the milch animals in Kerala is thus high when compared to the Indian average. However, the annual growth rate in milk production in the state has shown a negative trend with -1.1 % growth rates mostly due to the Kerala flood during August 2018against the national average of 5.68% during the year 2019-20.

The per capita availability of milk in the country which was 130 gram per day in 1950-51 has increased to 406 gram per day in 2019-20 against the world estimated average consumption of 314 grams per day in 2019. The average milk availability in Kerala is 189 grams per day with total annual production of 25.40 lakhs MT of milk. The total milk is produced in the state by 22,050 non-descript/indigenous cows, 6,44,310 exotic/crossbred cattle and 6590 buffaloes, as per 2019 Livestock Census.

The Animal husbandry and allied sectors have shown a promising improvement in the state in recent times though challenged by the flood during the year 2018, 2019 and the Covid 19 pandemic. While it is a welcome improvement, it must be noted that in spite of improvement in the milk production, the state is still not self-sufficient in terms of requirement and in house market availability milk. When seen in the context of slowing down of the economy, lose of employment in non-farm sectors, large number of expatriates returning to the state, warrants urgent planned and sustained interventions to improve the entrepreneurial opportunities in animal husbandry sector, especially in dairying. The Covid 19 pandemic period and post Covid19 periods will be great challenge to the health sector in the state. During the Covid 19 period the facilities are to be created and maintained for the patients. However the vulnerability of the population to other diseases and unexpected complications are predicted in the recovered persons. For increasing the resilience a food based approach will be the most appropriate one. Since more that 80% of the milk is produced in the state and mostly consumed by all the age groups natural fortification of the milk through scientific interventions in animal feeding and fortification during processing are the two options in improving the health of the population. Hence the sector needs more interventions and investment in the coming years.

Currently Kerala procures 3.2 lakh liters of liquid milk daily from neighboring states to meet the milk demand of the state. The figure is exclusive of milk products reaching Kerala from outside the state (like milk powder, dairy whitener, ghee, butter, ice cream etc.). A study by the National Council ofApplied Economic Research (NCAER) in 2014 argued that the total demand for milk was 27.9 lakh tones in 2009-10, whichwouldriseto32.9lakh tone in2020, 34.2 lakh tonne in 2025 and 35.2 lakh tonne in 2030. However, the projections went awry. The growing demand for milk and milk products in coming years due to population growth and demographic shifts due to rising incomes and urbanization, have to be taken into account while projecting the demand. Revival of the economy can surely make a huge demand for milk and milk products in the state.

Trend in Farm Size

Many of the traditional farmers are keeping one or two animals in their homestead. Dairy farming has transformed into an entrepreneurial activity and many small, medium and large farms were established in many parts of the state. The number of commercially operated farms in the table clearly indicates the trend of increase in the farm size.

Table 1. Classification of dairy farms by number of animals

Number of animals in dairy farms	Number of dairy farms	Share in total (%)
5 to10	9878	69.5
11 to 20	3166	22.3
21 to 50	984	6.9
51 to100	152	1.1
Morethan100	41	0.2
Total	14221	100.0

Effect of Covid 19 Pandemic

The crises that developed in the milk production sector were partly due to the lock down and the others due to cumulative effect of economic slowdown, a breach in the supporting services and disruption of the supply chain. In 2016, about 9 lakh litres of milk were imported into the State every day. By 2019, Kerala was able to reduce the dependence on milk imports from outside the State to about 3.5 lakh litres per day. This was because of a sharp rise in domestic production of milk through dairy cooperatives. However, during the period of lockdown, the demand for milk from the public sector (i.e., MILMA and Dairy Cooperatives) fell by 2.5 lakh litres per day. Similarly, the demand for milk in the private sector fell by about 4 lakh litres per day. This decline happened in a State that used to consume about 25 lakh litres of milk per day prior to the lockdown.

Breeding

The animal breeding activities were seriously affected during lockdown period and afterwards due to issues leading to postponement of animal breeding like containment zone formations, restricted movement of persons, limiting operations to emergency situations. This may seriously affect the milk production in the state resulting from reduction in the number of calving.In addition to that many of the farmers who usually purchase replacement stock for ensuring ready supply of milk from the farms were also not able to replace the dry animals with milking animals. This will have a cumulative effect. Hence the following strategies are recommended for the cattle breeding.

- A demand exists in the field for germplasma of high yielding dairy breeds. Such germplasma needs careful introduction in the field as the progeny may not be viable under less favourable farm conditions prevalent in the state. A two tier system may be advocated with the first tier consisting of regular pedigree bull semen (average to moderately high yielders) for common livestock farmers and a second tier with semen from high pedigree bulls for elite cows of farmers having farm environment conducive for animals with such genetic and phenotypic make up.

- Field level application of allied Assisted Reproductive Technologies like induced breeding and timely artificial insemination, use of sexed sorted semen should be explored.

- Confirming acceptable levels of fertility is an essential criteria for ensuring that the crossbred animals realize their genetic potential. Infertility among the crossbred cattle is a major long standing concern. The state average for age at first calving should be brought down to 24 – 30 months from around 4 years. Inter calving period should be also brought down to 12-14 months against the present 22 months. While the problem has been known for some time, the exact causes, which may be multiple, needs to be analyzed and identified for the strategic interventions to be made. Hence an integrated assessment of infertility prevalent in the crossbred dairy cattle of the state with the involvement of KVASU, AHD and the KLDB should be made. Focus should be directed on zone wise management of bovine infertility by establishing facilities/centres for effective surveillance, evaluation and intervention.

- Conservation of indigenous breeds to conserve the genetic variability (limited to breeds indigenous to Kerala) including recognizing of local breeds and use of assisted reproductive technologies to intensify conservation efforts. Steps to be taken to register Kasargode dwarf and other native cattle as breeds for effective utilization of Central Scheme. We need to promote high yielding indigenous cows.

Introduction of Animals

Local availability of cow is a concern for farmers and hence cows were purchased from outside state under various programmes. The concept of purchasing animals from outside the state to improve the state animal population needs a review as off late it has been argued that the animals brought from outside the state have contributed to an increase the disease incidence in the state (including haemo parasites and viral diseases). At the same time the benefits incurred to the state from the import of animals from outside the state cannot be ignored. Hence it is proposed to phase out the purchase of cows from outside the state with this 14th plan period. Under the circumstances a technical committee with experts from AHD, DDD, KVASU and beneficiaries of already implemented projects may be constituted to analyze the strengths and weakness of the purchasing animals for Government schemes from outside the state. The report and recommendations of such a committee may be looked into for purchase of the animals from outside the state.

Alternatively, entrepreneur based Heifer Nursery units to be promoted as a source of future milch cow herd. In similar lines, male calf/Buffalo rearing units may also to be promoted as a source good quality meat.

Feeds and Fodder:

Out of total cost60-70% of cost of rearing livestock is constituted by the feed and fodder costs. The lack of available land for fodder cultivation presents a major difficulty in supporting the fodder requirements of the livestock sector. The situation is worsened in the light of lack of quality concentrate feed and feed ingredients in the state. The dairy sector also faced a serious shortage of feed and fodder during the lockdown. Further, when Kerala attempted to import feed from a location in Andhra Pradesh, the trucks were not let through the Karnataka border. This has created a sense of uncertainty in the dairy feed sector. In the present situation non-availability of raw materials is not the cause of reduction in production of cattle feeds.

Hence the following measures may be proposed

1. Promoting commercial fodder production by assuring market through Co-operative societies and linking fodder cultivation with NREGS. The incentives should be provided through co-operative societies which assure market price to the fodder producers. This ensures accountability through the society and subsidized supply to the dairy farmer.
2. Promoting fodder cultivation in waste lands in public domain through SHGs/entrepreneurs and ensuring quality of the fodder produced by soil management.
3. Hydroponics and Azolla cultivation schemes implemented through allied departments may be reviewed by a high level technical committee with experts from AHD, DDD and KVASU.
4. MRDF (Malabar Rural Dairy Foundation) may be entrusted with collection, bailing, transport and distribution of straw from intensive paddy cultivation areas to needy farmers.
5. Since the price of milk cannot be increased, as an incentive to the farmers, subsidy should be given in the form of feed.

Other Supports

- Manure disposal- Financial assistance and beneficiary numbers to be increased for biogas units, dung pits, aerobic composting, sheds for stocking of dry dung to increase the availability of organic manure and avoid environmental related issues.
- Support from MNREGA &Ayyankali Nagara Thozhilurrapp Padhathi (ANREGS) - This can be effectively utilized for the development if dairy sector. Under MNREGA, in addition to the fodder cultivation, cattle shed construction, rain water

harvesting, dung and urine collection pit/shed can also be established. Similarly ANREGS, also be utilized effectively for the improvement of dairy sector.

- Lack of information about availability of cattle and allied inputs is a problem faced by farmers. Providing E-portal for handy information related to cows, farm produce, farm mechanization equipments and milk products may be considered.
- Consider scaling up of operation of DCS to ensure the viability with minimum of (200) liters, by amalgamation of adjacent DCS wherever possible.
- DCS may be empowered as Farmer Support Centers in addition to being mere milk collection areas. Farm support materials like milking machine, rubber mats, pressure washers, automatic drinking bowls etc. to be made available through DCS at competitive rates**.**
- Co-operatives were given land in public places to set up sale outlets in earlier days. This was helpful in ensuring the availability of milk and milk products to consumers. Off late, it has become difficult to set up outlets at such places. Steps may be taken to ensure that co-operatives do not face many obstacles to set up sales outlets. Additionally, co-operatives may be given land on lease at public places to open sale outlets for selling milk as well as locally available other primary agriculture produces.
- Co-operative brand to be strengthened to prevent the threat from invasion of cheaper milk from outside. Marketing strategy of Co-operative societies has to be modified.
- The Scheme NDPREM of Norka Roots can be utilized effectively for the expats who returned from foreign countries.
- At present there is no availability of milk replacer, which is essential to ensure proper growth rate at younger age. Due to this reason the actual production potential of the animal is not obtained. Steady supply of good quality milk replacer is to be ensured with a reasonable subsidy component.
- More Government support for Infrastructure Development for Regional Milk Unions and Non-APCOS societies so that profit from operations can be transferred to farmers
- Promote the Integrated farming system among the farmers for the sustainable dairy farming and food security and also need to promote climate resilient dairy farming system.

Preparation to Handle the Surplus and Product Diversification

One major lesson learned from the Covid19 pandemic to the animal husbandry sector in Kerala is the need to attain a greater degree of self-sufficiency in animal produce and handling it.

The pandemic has also reminded Kerala that it is close to attaining self-sufficiency in milk production. In the coming years, the State needs to prepare itself for a handling a situation of surplus milk. Kerala needs a modern milk powder plant as well as an evaporator plant to convert and store surplus milk as milk powder and condensed milk in the future. Prior to the erection of such a facility, feasibility studies should be carried out to ascertain the availability of excess milk , throughout the year.

We also need to aim at developing the production of value-added commodities from milk, such as cheese and yogurt. This implies setting up of advanced product diversification facilities in the existing dairy plants.

The government should undertake a study of the marketing and supply chains in the dairy sectors of the State, and initiate measures to remove bottlenecks from the producer to the consumer. The use of modern IT infrastructure, to develop the marketing network of milk in the State should be encouraged. This includes the linking up of all dairy cooperatives in the State under single inter-connected software.

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FEEDING STRATEGIES TO ENHANCE QUALITY OF MILK

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Kerala Veterinary & Animal Sciences University

Introduction

Quality of market milk in India is determined by two axis pricing policy where in along with percentage of fat, solid non fat percent composition is also considered as a quality parameter for providing incentives to dairy farmers selling milk. Nutritional needs reflected as milk quality through these two parameters are to be provided through feed without compromising on health as well as production of dairy animals. The most economic and nutritionally balanced options available to the farmer are to be given priority while formulating such strategies. Feeding management has profound influence on milk fat and protein concentration of milk. Nutritional strategies have to consider not only nutrient availability but also the optimization of the function of rumen microbiota that affects milk quality. Numerous dietary factors affect pattern of rumen fermentation and therefore determine the quality of milk. Factors that bring changes in the acetate to propionate ratio viz. forage to concentrate ratio, type of carbohydrate in the diet, physical form of the diet, processing of ingredients, additives, frequency of feeding and the method of offering feed are found to influence quality of milk.

Feeding Strategies to enhance quality of milk

Milk fat, lactose, and proteins are synthesized in the cells from precursors absorbed from blood and five hundred liters of blood has to circulate through udder to enable production of one liter of milk. An animal producing twenty liters of milk might so need 10000 liters of blood to pass through its udder at a rate of 420 liters per hour. Milk has almost 87 per cent water and dehydration has a profound effect on milk production. An adult dairy animal in India has a daily water requirement of 75-80 Liters of water. In addition to the above, a lactating animal require 2.5 to 3 liters of water per liter of milk production. Provision of automatic waterers along cow side 24*7*365 has been a welfare measure widely followed in most dairy farms but its effect from excessive drinking dilution enzymes and suppressing appetite during times of thermal stress need to be further investigated.

Dry Matter Intake need to be enhanced to 3-3.5% of body weight when animal arrives at peak production 4-6 weeks after parturition. A diet moisture percentage of 35% is known to enhance palatability and trigger intake by animals. Frequency of feeding need to be enhanced in summer and quantities are to be equally distributed. Feeding has minimal effect on manipulating percentage of lactose that exists as true solution in milk. Lactose is synthesized at epithelial cells of alveoli from blood glucose that combines with uridine diphosphate(UDP) galactose. Amount of lactose however determines the quantity of milk fluid by osmosis.

Milk Fat comprises of Short fatty acids comprising 4-14 Carbon atoms, Intermediate fatty acids comprising 14-16 Carbon atoms and long fatty acids comprising 18 and more carbon atoms. Short fatty acids are highly variable in quantity and synthesized in Mammary Gland from Acetate and Beta Hydroxy Butyrate and hence diet dependent. Intermediate fatty acids are part synthesized and part absorbed and long ones that are absorbed from blood. Both of these are relatively stable in quantity and get hydrogenated in the ruminal hydrogen sink before absorption. A 60:40 or 50:50 forage to concentrate ratio is optimal in maintaining high fat percentage and a ratio beyond 40:60 could drastically affect ruminal acidity and acetate as well as butyrate ratios. Cereal grains included as concentrate should have a low ruminal degradability. A maximum non structural carbohydrate level of 35% of dry matter intake is important in maintaining milk fat and works very well with diets having lesser than 60 percent forage. Cereal grains should be coarsely grinded or dry rolled as heating and steam flaking increases digestibility of starch. Animal producing 18 Liter milk should ideally be provided with 5-7 Kg grains that are served in 6 divided doses. These doses should be ideally mixed with hulls/straw having good structural carbohydrates to prevent acidity. Separate feeding of forage and concentrate results in selective feeding and increased preference for concentrate over roughage by few animals depleting their diet from structural carbohydrates that results in acidity. Introduction of feeding as total mixed rations could help animals to overcome such problems effectively. Ration fiber levels are of utmost importance in stimulating salivation & rumination. Saliva produced aid in buffering activity and acetate production there by directly affecting milk fat composition. Ideal fiber levels in ruminant diet should be 50-60% of dry matter intake. Fibre in complete diets should be of such quality that it could daily contribute neutral detergent fiber component at the levels of 1.2-1.4 percentage of body weight. An ideal TMR is suggested to contain in the dry matter consumed at least 28%-34% as neutral detergent fiber and 18% -24% as acid detergent fiber. Buffers like sodium bicarbonate and magnesium oxide optimizes ruminal microbial digestion and probiotic are also considered to optimize ruminal fermentation.

Vegetable oils are not recommended for ruminants beyond 3% of diet as unsaturated fatty acids could prove toxic to population of fibre degrading bacteria in rumen. Supplementation of unsaturated fat/oil reduces fibre digestion, thereby defeating the major objective of increasing the availability of energy. Supplementation of fat to dairy cows could be effectively achieved by means of Rumen Un-degradable Fat/ Escape Fat that passes the rumen without any degradation. **Rumen-**protected fats are calcium salts of long-chain fatty acids. Ruminants are known to obtain amino acids from two sources namely microbial proteins and rumen un-degraded/escape protein. Diets for dairy cows should contain both rumen degraded protein and escape protein at an ideal ratio of 65:35. Escape proteins are known to directly enhance **milk protein concentrations.**

QUALITY ASSURANCE OF MILK AT FARM LEVEL PRODUCTION

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1. INTRODUCTION

Dairy sector plays vital role in the economic development of country by enhancing farmer's income and catalyses sustainable agriculture. It also provides gainful employment in the rural sector particularly among the landless farmers, small and marginal farmers, women and weaker sections. It acts as both supplementary and complementary enterprise. Animal Husbandry sector contributes 16 percent of income of small farm households and provides livelihoods to about two-third of the rural community. It also provides employment to about 8.8 percent of the population in India and contributes 4.11 percent of GDP (Gross Domestic Product) and 25.6 percent of total agricultural GDP.

Dairying in Kerala shows the fastest growth in production sector. It contributes 27 percent of total agricultural GDP which is higher than national average. It provide one of the principal sources of livelihood especially for agricultural laboures, small and marginal farmers, women etc. and about 8 lakhs families are engaged in dairy farming. As per the livestock census in 2019 cattle population in Kerala was 13.42 lakhs and estimated increase of 1.02 percent than the previous census in 2012. Kerala recorded highest percentage of cross bred cows in the country (94%) and second highest average in milk production (10.52 liters per day) stand behind Punjab. The milk production during 2019-20 was 25.42 lakh metric tons.

There is an organized network of cooperative sector in dairy sector with better infrastructure facilities for procurement, chilling and processing of milk. There are 3342 functional primary dairy cooperatives well distributed in the state. The average procurement of milk through primary dairy cooperatives was 19.5 lakh liters per day (Total procurement 7.12 lakh metric ton) during 2020-21 which is about 28 percent of the total milk production. The supply chain is also remarkable. Almost equal quantity of milk is handled by MILMA and private sector including charitable organizations.

2. UNIQUE FEATURES & SCOPE

Kerala is having some uniqueness in dairy sector. Some of the features are mentioned below.

- Highest percentage of cross bred cows (94%) in the country.
- Second highest in average milk production from cross bred cows (10.18 liters per day in 2015-16).
- Better infrastructure facilities at field level especially among marginal and small farmers and agricultural laboures.
- Established almost 100 percent cold chain. Most of the dairy plants are procuring only chilled milk from primary dairy cooperatives.
- About 98 percent of milk produced from cows, 0.08 percent from indigenous cows, 5.02 percent from goats and 1.65 percent is contributed by non-descriptive cattle and indigenous as well as non-descriptive buffaloes.
- Higher level of the quality awareness and concern of the consumers in Kerala.

The better infrastructure facilities available at farm level indicates the possibility of better quality of milk produced at the source of production. The cold chain facilities at primary dairy cooperatives create opportunities for maintaining the quality of milk produced at cutting edge level. The hygienic production of milk from cows assures acceptance of products at international level. The quality awareness of consumers in the state opens the better local market of milk and milk products from superior quality of milk.

3. CLEAN MILK AND PUBLIC HEALTH

The rapid growth in urbanization opens up an assured market for milk. However, the procurement of milk is effected from a vast number of households; we often face difficulty in monitoring safe milk production. Since most of the consumers have demanded for fresh milk it is the need of the hour to educate our farmers for clean and safe milk production. It is apt to remember that milk with minimum bacterial load greatly influences the quality of finished products. It also doubles its shelf life without preservatives.

Since milk is considered to be almost complete food and provides a palatable environment for the growth of microbes. Many of the communicable diseases can be transmitted to human by the consumption of contaminated milk. These diseases causing pathogen can only be removed by milking with at most care in terms of milking environment, handling and management of cows. The following are the list of few diseases that can be transmitted through unhygienic condition.

4. MILK BONE DISEASES

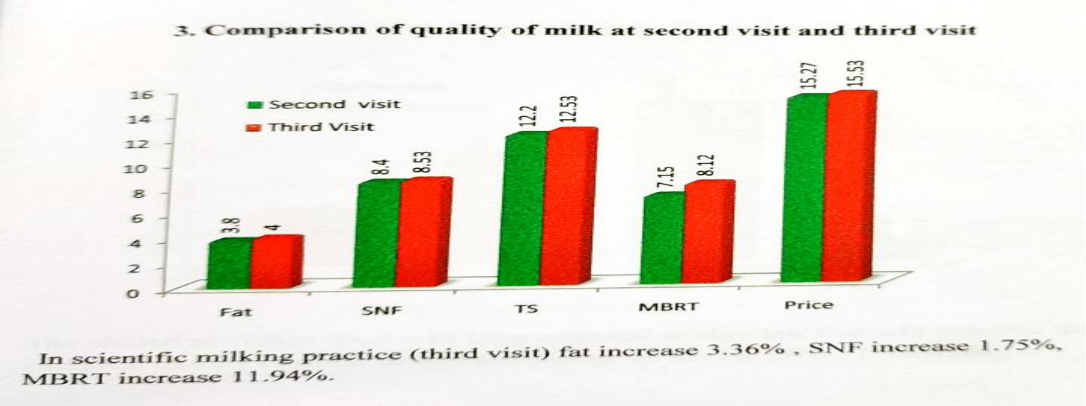
Name of Disease	Causative Organism	Symptoms
Brucella infection (Brucellosis)	Brucellaswis, Brucellaabortus, Brucellameletensis	Undulant fever (Malta fever)
Diphtheria	Brucella sp.	Chill, fatigue, fever, hoarseness, cough
Scarlet fever	Brucella sp.	Fever, nausea, brumby tongue, red tonsils
Septic sore throat	Streptococcus sp.	Sore throat, chill, fever, swollen bumpy node
Food poisoning	Bacilluscereus	Diarrhea
Food poisoning	Cambylobacterjejuni	Diarrhea and abdominal cramp
Q Fever	Coxiellaburnetti	High fever for two weeks,
Bloody diarrhea	E. coli	Hemolytic uremic syndrome (bleeding and kidney failure)
Listeriosis	Listeriamonocytogens	miscarriage
Crohn's disease	Mycobacteriumavium	Inflammatory birds syndrome
Lung disease like TB	Mycobacteriumbovis	Breathing difficulty, pus in lungs
Tuberculosis	Mycobacteriumtuberculinum	Fever, inflammation in lungs
Diarrhea	Salmonella sp.	Diarrhea, fever
Typhoid	Salmonellatyphi	High fever, lung infection, diarrhea
Food poisoning	Staphylococusaureus	Explosive vomiting and diarrhea
Food poisoning	Yersinieaenterocolytica	Enterocolytical abdominal cramp
Food poisoning	Shygelladysentriae	Shooting diarrhea, death due to dehydration

5. HEALTH HAZARDS

- Use of preservatives for extending the shelf life of milk can impair digestibility and may damage digestive organs.
- The common adulteration pattern by adding water to milk not only alters nutritive value but also induce contamination.
- Milking in dusty environment adds up spore forming microbes can overcome through pasteurization treatment.
- Consumption of contaminated milk induces food infection and the severe case may lead to mortality.
- The higher level of aflatoxin may lead to health hazard.
- Addition of antibiotics or preservatives in milk may lead to the formation of antibiotic resistant microbes (super microbes).

6. QUALITY ASSURANCE OF MILK AT FARM LEVEL

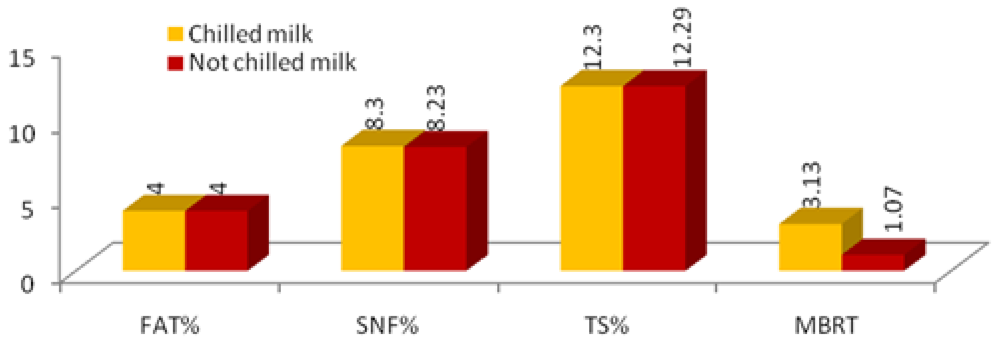
6.1. FIELD VISIT



6.2. Quality of milk and milking time

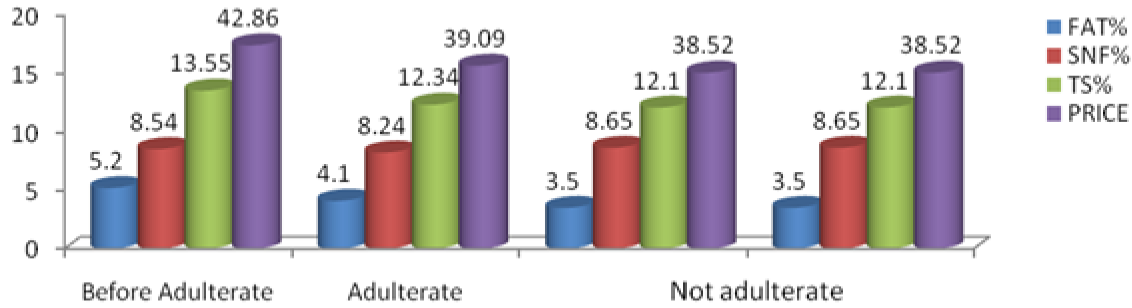
There is a relationship between the milking time and chemical quality of milk. When the milking time is reduced from 10 minute to 7 minute there is an increase of the chemical quality i.e. 11.11 % FAT, 4.68 % SNF, 6.59 % TS.

6.3. Effect of milk chilling at society level

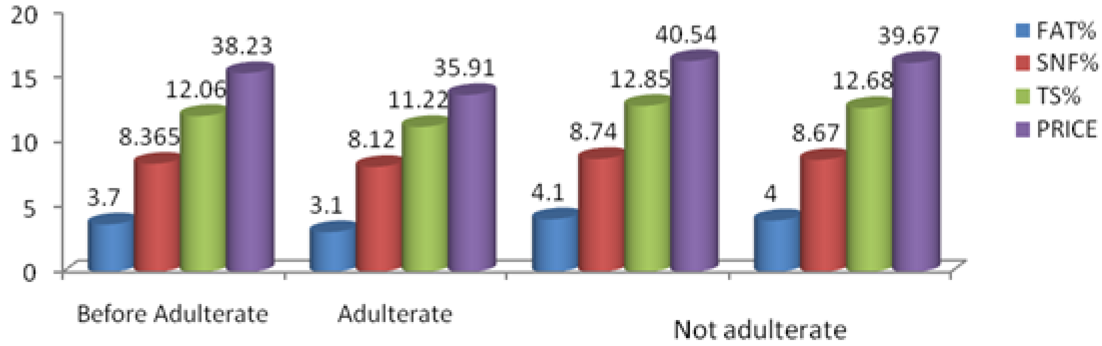


The chilled at village level will keep acquired acidity law that will improve the chemical quality of milk. It will not change on the Fat, SNF, TS of milk

6.4. Adulteration



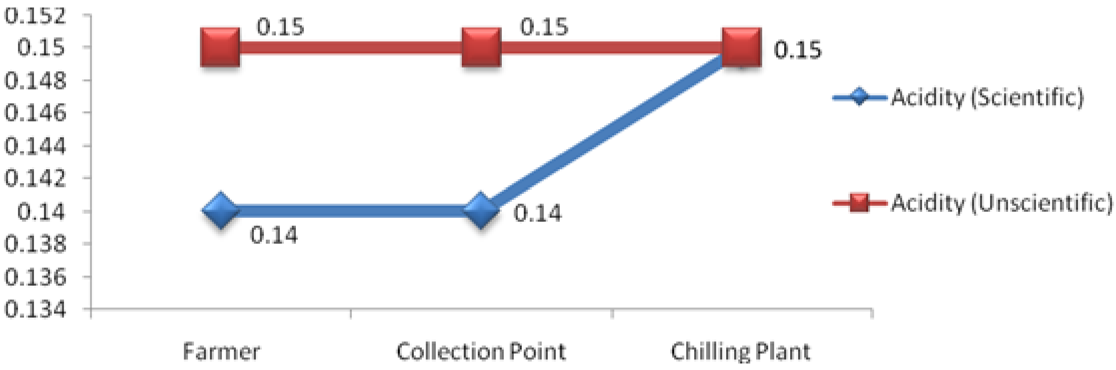
3. a. Nature of milk



6.3. b. Nature of milk

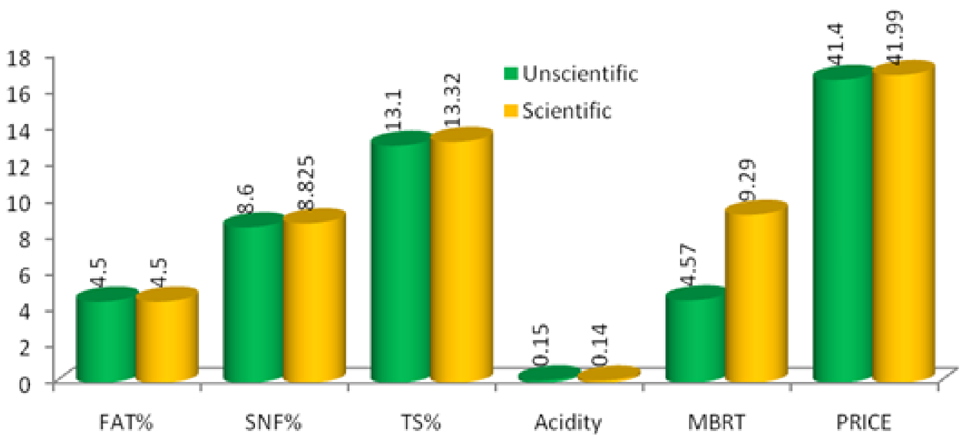
The adulteration of milk with water knowing or unknowing the farmer will decrease the FAT, SNF & total solid of milk. Which the farmer will lose around rupees 2 per liter. Unknowing adulteration of milk is carried out by the unscientific milking practices like non wiping of udder utensil etc and dissolving forth of milk in water. It is observed that 22 % farmers are purposely adulterate.

6.5. Acidity of milk



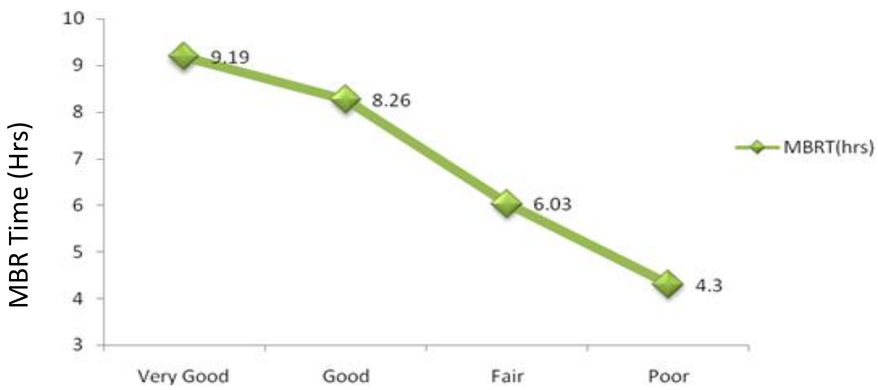
The acidity of milk from farmers to the chilling plant is increase from 0.14 to 0.15. There is a deterioration of acidity 0.01

6.6. Deterioriation of milk quality with unscientific milking practice



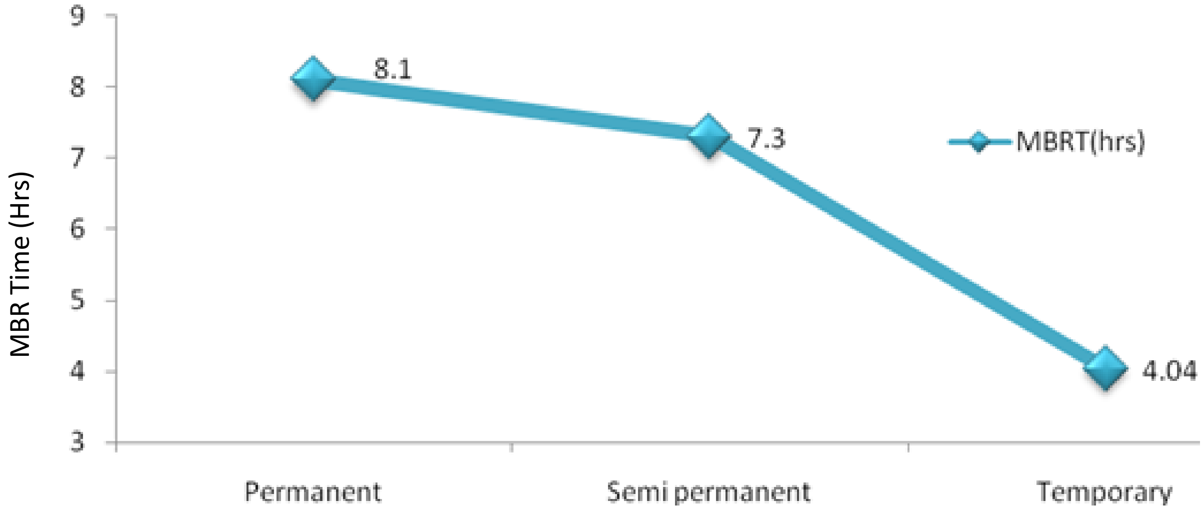
The scientific milking practices will increase the SNF, physical quality, biological quality and price of milk.

6.7. Effect of hygiene and quality of milk



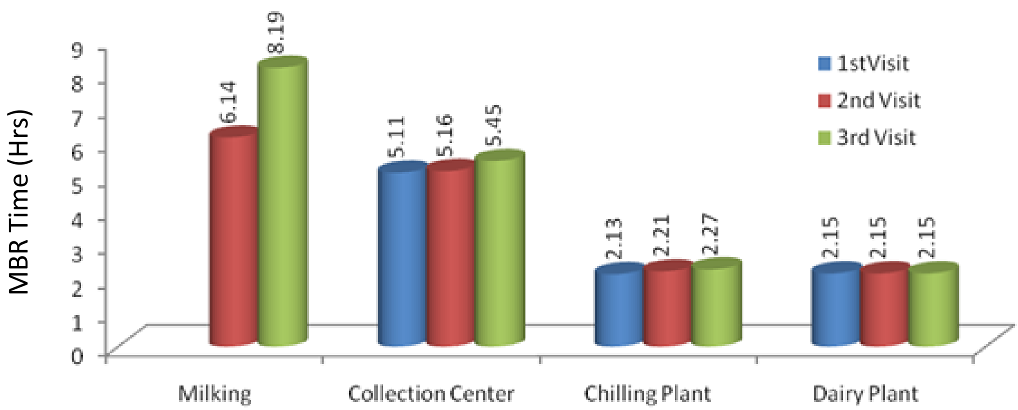
Hygiene of animal

It is vivid that the Hygiene of milking animal has great influence on the physical and biological quality of milk and can be even more than double the MBR time of poor and very good. The average level of the hygiene of the animal which categories very good, good fair and poor shows MBR time of 9.19 Hr, 8.26 Hr, respectively.



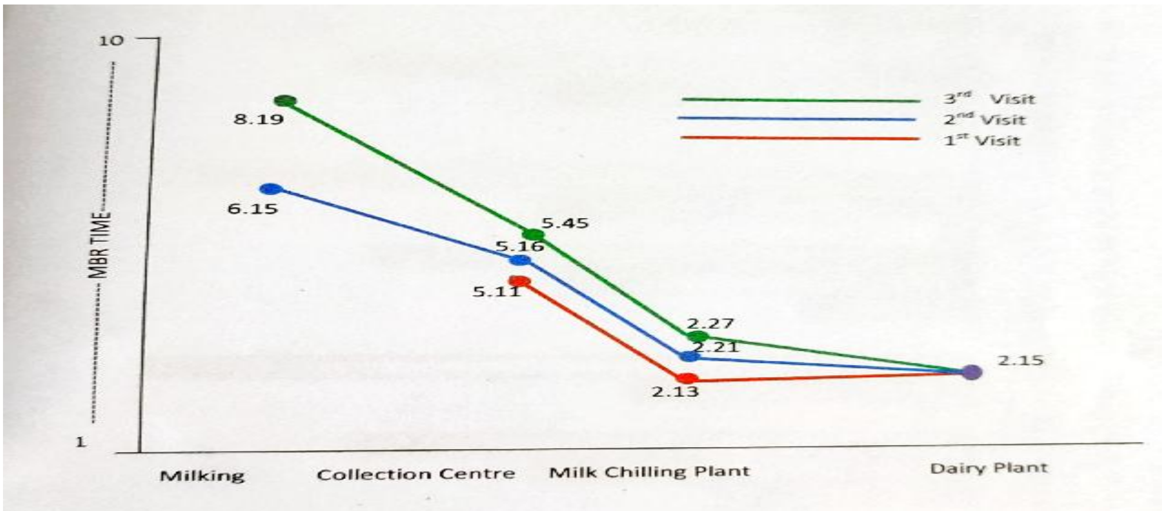
The condition of the cattle shed (Permanent, Semi Permanent, Temporary) is also influence the physical, biological quality of milk.

6.8. Effect of biological quality and time



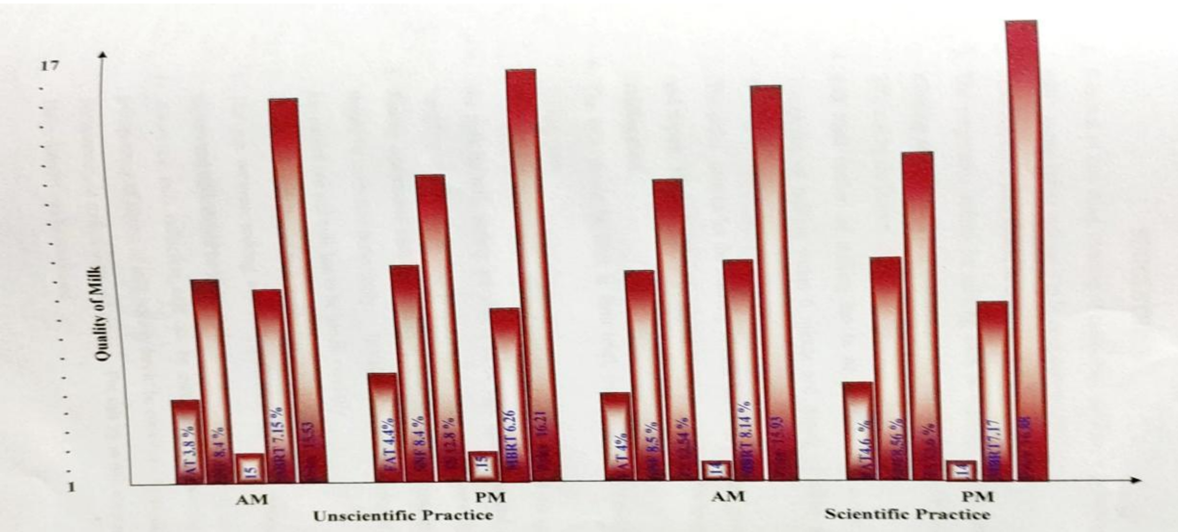
The time between the milking of animal and milk procurement is as crucial factor. If the time gap increases the acidity also increases and biological quality decreases. This shows that the physical, chemical and biological qualities are deteriorated proportionally. The biological quality is decrease from 8.19 Hr. MBR to 2.15 Hrs. MBR.

6.9. Effect of biological quality and time



The time between the milking of animal and milk procurement is as crucial factor. If the time gap increases the acidity also increases and biological quality decreases. Which shows that the physical, chemical and biological qualities are detoriated proportionally. The biological quality is decrease from 8.19 Hr. MBR to 2.15 Hrs. MBR.

6.10. Importance of Scientific Milking Practice



The unscientific milking practice of cows decreases the physical, chemical and biological quality as well as price of milk.

7. SUGGESTIONS TO IMPROVE QUALITY OF MILK AT FARM LEVEL

Scientific milking practice is the most important aspect for improving the quality of milk. The health condition of cattle is also influences the above. The Infrastructure facilities such as cattle shed, drainage, separate collection of cow dung and urine, chaff cutter, storage of feeds and fodder etc. have to be established and proper designing is necessary. The animals, cattle shed and surroundings have to be maintained properly and hygienically. Feeds and feeding, care and management are to be scientific. The usage of clean milk production kit helps in producing safe milk. The hygienic condition of the utensils and equipments pertaining to contact of milk is also important. The post milking activities and time frame also affects the quality of milk. There should be proper awareness among the dairy farmers.

8. ACTIVITIES OF DAIRY DEVELOPMENT DEPARTMENT

The schemes implemented by Dairy Development Department such as farmers contact program, consumers awareness program, distribution of clean milk production kit, construction of cattle shed, dairy farm mechanization, need based assistance can ensure safe milk production. In addition to this the schemes of Local Self Governments and services of MILMA and Dairy Cooperative Societies can also be used.

9. CONCLUSION

A major finding in the survey (conducted by FSSAI) was found the presence of Aflatoxin M1 residues beyond permissible limits in 368 (out of 6,432) samples, that is 5.7% of the samples. This is the first time that such a detailed survey regarding the presence of Aflatoxin M1 in milk has been done in the country. Aflatoxin M1 comes in the milk through feed and fodder, which are currently not regulated in the country. Amongst the top three States with highest levels of Aflatoxin M1 residues are Tamil Nadu (88 out of 551 samples), Delhi (38 out of 262 samples) and Kerala 37 out of 187 samples). The survey however shown that about 41% samples, though safe, fall short of one or another quality parameter. Both raw and processed samples were found non-compliant on account of low fat or low SNF or both. Proportion of fat and SNF in milk varies widely by species and depends on breed as well as quality of feed and fodder. Cattle must be properly fed and maintained under good dairy farming practice. Non-compliance on these parameters in raw milk could be for these reasons or due to dilution of milk with water.

Kerala has attained self sufficiency and surplus in milk production even under Covid 19 pandemic situation especially in cooperative sector. The above field study reveals that for attaining the current level of physical, chemical and biological quality of raw milk to international standard through the implementation of hygiene, scientific and clean milk production practice, reduction of time between milking and chilling etc. The implications of non financial effective extension activities are required rather than the creation of infrastructure. In addition to this, it is also necessary to have new approach in the processing, value addition and marketing of milk and milk products with international standard. Since the milk is an almost complete food, highly perishable and ideal medium for growing microbial organisms, the quality assurance has to be observed throughout the supply chain. Quality assurance at farm level is very critical for the milk industry with safe milk concept.

CHEMICAL QUALITY OF MILK AND MILK PRODUCTS

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Introduction

Milk quality has very important role in human health because of its wide consumption by all age group of people and also its conversion into various value added products like butter, ghee, cheese, ice cream, yoghurt etc. The compositional parameters of milk make it a suitable medium for adulteration and bacterial attack. Since milk contains major amount of water, (approximately 87%) it act as a solvent for various adulterants and also the other nutrients present in milk such as protein, fat, Lactose makes it a good medium for bacterial growth. Milk quality comprises of its hygienic quality, Microbial Quality and Chemical Quality. Good quality milk should be free from any sediment, off flavor, adulterants, contaminants and of bacterial contamination. In this chapter, we are focusing on the chemical quality of milk. Chemical Quality of milk mainly depends on its compositional parameters and physic chemical properties such as acidity, pH, specific gravity etc. Various analytical methods are used to assess the chemical quality of milk and milk products. The accuracy of the chemical quality tests depends upon the correct sampling procedures adopted and also the selection of proper temperature specified for each method. The reagents should be of standardized and the glassware and instruments are to be properly calibrated.

Testing methods for chemical quality parameters of milk and milk products

Platform Tests

These tests are performed at the reception dock where milk is received and checked for its quality using various tests before either rejecting or accepting the milk supply for further processing.

Organoleptic test

Organoleptic test are used for judging the quality of milk by its taste and smell and requires considerable skill which could only be acquired by practice.

Procedure:

Remove lid from the can/tanker and observe for any extraneous matter present. Sniff the milk for any objectionable flavor that is un-natural of milk. Put small quantity (10 – 20 ml) on tongue and roll into mouth cavity for any off taste that is un-natural of milk and spill out. In case of doubt, subject the sample to other tests. Based on organoleptic evaluation accept or reject the milk.

Clot-on-boiling test (COB)

This is a quick test to determine developed acidity and to assess the suitability of milk for heat processing.

Procedure:

Take 5.0 ml of milk in a 20 ml test tube using graduated pipette. Place the tube in boiling water bath for five minutes or hold the tube over a flame and allow the contents to boil. Formation of clots or flakes on the test tube wall indicates positive test. This further indicates that the milk has high developed acidity and is not suitable for heat processing.

Alcohol test

The alcohol test is used for rapid assessment of stability of milk to processing, particularly for condensing and sterilization. This test gives an indication of the mineral balance of milk. The test aids in detecting abnormal milk such as colostrum, milk from the animal in the late lactation, milk from animal suffering from mastitis and milk in which mineral balance has been disturbed.

Procedure

Take 5.0 ml of milk in a test tube using graduated pipette. Add equal amount of ethyl alcohol (75% ethyl alcohol for cow milk and 68% ethyl alcohol for buffalo milk). Close the mouth of the test tube with thumb and mix the contents well by inverting the test tube several times. Formation of any flakes on the wall of the test tube indicates positive test.

Alcohol –alizarin test

The test is similar to the alcohol test and the incorporation of Alizarin helps to indicate the approximate percentage of acidity. So this test also indicates the suitability of milk for high heat treatment and to have idea about milk acidity without acidity test.

Procedure

Transfer 5.0 ml of milk in a test tube using graduated pipette. Add equal amount of alcohol alizarine solution (0.2%).Mix the contents well by inverting the tube several times. Observe for formation of flakes and color of the contents. Match your results with following table

Range of Colour	Presence of Flakes	Approximate Acidity (%)
Pale red	Nil	0.16
Reddish Brown	Small	0.20
Yellowish Brown	Small	0.24
Brownish Yellow	Large	0.28
Yellow	Large	0.36

Detection of neutralizers

Alkali in various forms like sodium carbonate, sodium bicarbonate, sodium hydroxide and lime are used to neutralize developed acidity in milk. Detection of such neutralizers can be made by the following two tests.

1. Rosalic acid test

Take 5 ml milk in a test tube of capacity 20 ml. Add 5 ml ethanol (95%,v/v) and 4 drops of Rosalic acid solution (0.05%; w/v in ethanol). Mix the contents. If carbonate or bicarbonate is present a pink color will appear. If NaOH is present a deep rose red color will appear.

2. Alkalinity of ash test

Take 20 ml milk in a silica crucible. First evaporate the water to dryness, and then burn the content to ash in a muffle furnace at 550°C. Disperse the ash in 10 ml distilled water and titrate the ash content against N/10 HCl using phenolphthalein as indicator. If the volume of N/10 HCl exceeds 1.20 ml, then the milk contains the added neutralizers.

Laboratory Tests

Acidity test

Normal acidity of milk is due to its constituents like casein, citrates, phosphates and CO2. This acidity can be measured by titrating milk against a standard alkali solution using an indicator and is expressed in terms of lactic acid. The aim of the test is to assess suitability of milk for heat processing.

Requirements
Pipette, porcelain dish, glass stirring rod, burette (50 x 0.1 ml), Sodium hydroxide solution (N/10), phenolphthalein solution (0.5%)

Procedure
Transfers 10 ml of milk into a white porcelain dish, with the help of pipette add 1.0 ml of 0.5% phenolphthalein solution as indicator. Titrate the contents with N/10 NaOH solution. Observe occurrence of pink color as end point for the titration. Note the titre value. Calculate percent acidity of the sample as lactic acid.

Calculation

$$\text{Titratable Acidity (\% Lactic acid)} = \frac{9 \times N \times V_1}{V_2}$$

Where, V_1 = Volume of N/10 NaOH used
V_2 = Volume of milk sample
N = Normality of NaOH used

<u>Determination of Fat in Milk and Milk Products</u>
Fat is the most important and valuable constituent of milk and milk products. It also plays an important role in the pricing of milk and milk products.

Estimation of fat in milk can be done in two ways:
1. Gerber method
2. Gravimetric method (using Rose-Gottlieb method)

Butyrometer

Gerber method
Determination of fat in milk

Principle:

When a definite quantity of sulphuric acid and amyl alcohol are added to a definite volume of milk, the proteins will be dissolved and the fat will be set free which remains in liquid state due to heat produced by the acid. The amyl alcohol used facilitates the separation of a clear fat column. On centrifugation, fat being lighter will be separated on top of the solution.

Requirements

Gerber centrifuge, Gerber butyrometers for milk (0-10% scale with 0.1 per cent mark). Hot water bath maintained at 65°C ±2°C. 10 ml automatic measure for acid, 1 ml automatic measure for amyl alcohol, 10.75 ml milk pipette, butyrometer stoppers, butyrometer stand, key for stoppers, Gerber sulphuric acid density 1.807 to 1.812 g/ml at 27°C corresponding with a concentration of sulphuric acid from 90 to 91% by weight. Iso- amyl alcohol 95% of clear, colorless liquid and shall distil between 130°C to 132°C having density 0.803 to 0.805 g/ml at 27°C.

Procedure

Take 10 ml of Gerber sulphuric acid from automatic measure into the butyrometer. Pipette out 10.75 ml of the well mixed sample of milk and transfer it to the butyrometer carefully without allowing it to mix with the acid. This is done by allowing the jet of milk from the pipette to hit the inside wall of the butyrometer by holding the pipette in a slanting manner and resting the tip end on the mouth of the butyrometer. With the help of automatic pipette add 1 ml iso - amyl alcohol to the above butyrometer. Insert the stopper with the help of key and tight the stopper and mix the content by shaking the butyrometer at a 45 degree angle until all the curd has been dissolved. Keep the butyrometer in the water bath at 65°C ± 2°C for 5 minutes. Place the butyrometer in the centrifuge and balance the machine. Centrifuge for 5 minutes, (1000-1200 rpm). After centrifuging, temper the butyrometer in the water bath at 65°C ± 2°C for 5 minutes. With the help of key, adjust the fat column within the scale on butyrometer and take the reading and record the fat percentage. Care must be taken not to wet the neck of the butyrometer while adding Gerber sulphuric acid, milk and amyl alcohol. The test must be repeated if particles of curd are observed.

<u>Determination of fat in cream</u>

Apparatus

As in the case of milk except cream butyrometer (0- 70%) and a physical balance

Reagents

Fifty per cent Gerber sulphuric acid prepared by mixing equal volumes of sulphuric acid and distilled water at the time of experiment. Iso - amyl alcohol as in the case of milk.

Principle

Same as milk

Procedure

Stir the sample by carefully without causing frothing or churning. If the cream is very thick warm to 30°C-40°C to facilitate mixing. Immediately before weighing mix the sample. Keep the cream butyrometer with a small funnel at the mouth in a convenient conical flask and weight it. Then weigh accurately 5.00 ± 0.01 g of the cream into it. Add small quantities of the freshly prepared acid to the funnel to ensure complete washing down of the cream to the butyrometer. Add about 18-20 ml of the dilute acid to the butyrometer leaving sufficient space for the addition of amyl alcohol. Add one ml of amyl alcohol and proceed as in case of milk.

Determination of fat in Dahi

Apparatus

Same as given under milk

Reagents

Same as for milk

Principle

It is same as for milk. In addition, ammonia is added to liquefy the curd particles and to make the sample homogeneous.

Procedure

Weigh 100 g of the well mixed dahi sample in beaker. Add 5 ml of strong ammonia to the weighed sample and shake well to make it homogenous. Take the above prepared sample and proceed as in the case of milk. Multiply the result obtained by the dilution factor (in this case 105/100) and add the same to the obtained result to get the actual result. (Rose-Gottlieb method such as in milk can also be adopted-FSSAI Manual)

Determination of fat in cheese

Apparatus

Gerber centrifuge; Cheese butyrometer (0- 40%), tilt measure of 10 ml and 1 ml capacity

Reagents

Gerber sulphuric acid (sp. gr. 1.820 at 15.6°C); iso-amyl alcohol

Principle

Same as in milk

Procedure

Weigh accurately about 3 ± 0.01 g of cheese sample into the cheese butyrometer. Add 10 ml of warm distilled water (30°C -40°C). Add 10 ml of Gerber sulphuric acid into the butyrometer. Add 1 ml of iso-amyl alcohol. Close the butyrometer with the stopper and shake well till all the contents are well mixed. Place the butyrometer in a water bath at 65°C ± 2°C for tempering. Shake periodically until the solution of cheese is complete. Centrifuge at 1200 rpm for 5 minutes. Read the percentage of fat by adjusting the fat column within the scale of the butyrometer.

<u>Determination of fat in butter</u>

Apparatus

As in the case of milk except butter butyrometer (0- 90%) and a physical balance

Reagents

Fifty per cent Gerber sulphuric acid prepared by mixing equal volumes of sulphuric acid and distilled water at the time of experiment. Add iso-amyl alcohol as in the case of milk.

Principle

Same as milk

Procedure

Weigh accurately about 5 ± 0.01g of butter sample in 25 ml beaker and mix it with small portion of 1:1 sulphuric acid. Transfer the contents into the butter butyrometer. Dilute sulphuric acid with distill water and add 15 to 20 ml in butyrometer. Add 1 ml of isoamyl alcohol. Rest of the method is same as in case of milk.

Rose-Gottlieb method

This method of fat estimation is used as a reference method. The method is a gravimetric in nature unlike Gerber method which is a volumetric method and is followed for routine purposes

<u>Determination of fat in milk and milk product</u>

Apparatus

Fat extraction apparatus (Rose-Gottlieb tube), Oven at 100 ± 2°C, Water bath boiling.

Reagents

Concentrated ammonia solution, concentrated HCl, Ethyl alcohol, Diethyl ether (solvent ether), Petroleum ether (40-60°C).

Principle

For quantitative separation of fat from milk and milk products, it is necessary to break up the protective film surrounding the fat globule by using suitable agents (ammonia in case of liquid milk, and concentrated HCl in case of concentrated /dried milk products). Ammonia/Concentrated HCl brings about the break up of the protective layer. Ethyl alcohol facilitates the passage of fat from the aqueous phase to the solvents. The fat after extraction gets dissolved in the mixture of solvents (diethyl ether and pet. ether)The fat dissolved in the solvent mixture is collected in a tared conical flask containing 2-3 glass beads and then the solvents are evaporated on the water-bath and the finally dried in the oven. The weight of the dried fat in the flask is taken and percentage in the product is calculated.

Procedure

Weigh accurately a known quantity of well mixed sample (for example, 10 gm of liquid milk or 1 gm of concentrated/dried milk product) into the fat extraction (Rose-Gottlieb) tube. Add

1 ml conc. ammonia in case of liquid milk or 10 ml of concentrated HCl in case of concentrated/dried milk products and mix well. In case of concentrated dried milk products', heating is done on a water bath till casein has dissolved, then contents are cooled. Add 10 ml of ethyl alcohol and again mix well. Add 25 ml of diethyl ether (solvent ether) and mix properly. Then add 25 ml of petroleum ether (40-60°C) and again mix properly. Allow the extraction tube to stand till the two layers are separated clearly (Approx. 30 minutes). Siphon off the ether solution i.e. upper layer into the tared conical flask containing 2-3 glass beads. Repeat the process of extraction at least twice using 15 ml. of solvent ether and 15 ml of petroleum ether, and similarly pour these two extracts into the same tared conical flask. Evaporate carefully the solvents from the flask over a boiling water bath. Dry the residual fat in the oven at 100 ± 2°C for 1-2 hours. Cool the flask to room temperature in a desiccator and weigh it. Repeat the process of heating, cooling and weighing till you get a constant weight.

Observations

Weight of sample taken = W gm

Weight of empty tared flask with glassbeads = W1 gm

Weight of empty tared flask with glassbeads + fat after drying = W2 gm

Weight of fat in the flask = W2 - W1 gm = X gm.

Calculations

$$\text{Percent fat in the milk or milk product} = \frac{X \times 100}{W}$$

Precautions: Solvents like Diethyl ether, Petroleum ether and ammonia should be stored at low temperature before opening the bottles. There should not be any naked flame near the place of experiment, since solvents used in this experiment are highly inflammable.

Determination of Solids-Not-Fat Content (SNF test) in Milk

Solids-not-fat content (SNF test) by lactometer

Lactometers are used for rapid determination of specific gravity of liquids. The method is based on the law of floatation, which states that when a solid is immersed in a liquid it is subjected to upward thrust equal to the weight of liquid displaced by it and acting vertically upwards. Lactometers are variable immersion type hydrometers and calibrated with liquid of known specific gravity.

Requirements

Lactometer calibrated at 27°C (BIS), lactometer jar, thermometer.

Procedure

Adjust the temperature of milk sample to measuring temperature prescribed for lactometer (27°C). Mix the sample well to avoid incorporation of air or foam formation. Pour sufficient milk into the glass or steel cylinder to allow free floating of lactometer. Place the lactometer in the milk and allow it to float till it stops and assumes a constant level. Record the lactometer reading and temperature of milk at the same time. Take another reading by flapping the top of the lactometer stem and when it again assumes constant level. Take average of the two readings. Get corrected lactometer reading (CLR) from the standard table for corresponding temperature. Calculate solids-not-fat (SNF) content using the given formulas.

Calculations

Percent SNF=CLR/4+0.25 F+0.44 Where; F= Fat percentage in milk sample.

Total solid content of milk by gravimetric method

Whole milk contains about 84 –87% water and remaining 13-16% are solids comprising of fat, protein, carbohydrate and minerals. By evaporating water from the milk under controlled conditions the total solid content can be determined accurately.

Requirements

Aluminium moisture dish, boiling water bath/hot plate, weighing balance, hot air oven, desiccators, tong.

Procedure

Weigh accurately a clean and dry empty dish (A). Transfer 5.0 ml of sample into the dish and note the weight (B). Place the dish on boiling water bath or hot plate for 20-30 minutes. Allow the water to evaporate. Place the dish in hot air oven at 100 ± 1°C for 3 hours. Transfer the dish to a desiccator and allow cooling for 30 minutes. Weigh the contents and note the weight (C). Repeat heating and cooling until difference in two successive weights do not exceed 0.5 mg.

Calculations

Weight of sample (X) = Reading B – Reading A

Weight of solids in milk (Y) = Reading C – Reading A

$$\text{Percent Total Solids} = \frac{Y \times 100}{X}$$

<u>Determination of Lactose Contents in Milk and Milk Products</u>

The lactose in milk and milk products may be quantified by methods based on one of the five principles namely polarimetry, oxidation-reduction titration (Lane- Eynon method), colorimetry, chromatography and enzymatically. Polarimetric method is simple, accurate and rapid for the estimation of lactose in milk and milk products. However, Lane- Eynon method is most commnly used and widely accepted method.

Lane-Eynon method

Principle

Reducing sugars, which are more common, are able to function as reducing agents because of free aldehydic/ ketonic groups present in the molecule. The reducing properties of these sugars are usually observed by their ability to reduce metal ions notably copper, iron and silver in alkaline solution. Those very properties of sugars have been used in this method. The reducing sugar solution reduces an alkaline cupric-salt solution during boiling and converts into the red cuprous oxide. From the reduced amount of copper salt, the quantity of reducing sugar is estimated. Fehling solution is a mixture of Fehling A (CuSO4.H2O) and Fehling B (alkaline sodium potassium tartarate). When copper sulphate is made alkaline, it gives the blue colored precipitates of Cu $(OH)_2$. But the presence of sodium potassium tartarate forms a soluble blue colored complex of copper compound behaves as if it is alkaline Cu $(OH)_2$ solution. In general, when NaOH is added CuSO4, a blue precipitate of Cu $(OH)_2$ is obtained (Fehling A). These precipitates are made to dissolve in Rochelle salt solution (Fehling B) and a blue color solution is obtained, which is known as Fehling solution. The Fehling solution when heated gives rise to cupric oxide (CuO) which in turn reacts with reducing sugar and gets reduced to cuprous oxide (Cu2O) brick red precipitate and resulting into the oxidation of sugars to corresponding acids.

Reactions

$CuSO_4$+ 2NaOH → Na2SO4 + Cu(OH)2

RCHO+ 2Cu(OH)2 → RCOOH+2H2O+Cu2O↓

Reagents

a) Fehling solution A
   Weigh 34.639 gm CuSO4.5H2O and dissolve in distilled water. Add 0.5 ml of Concentrated H2SO4 and make the volume to 500 ml.
b) Fehling solution B

   Weigh 173 gm Rochelle salt and 50 gm NaOH and dissolve in distilled water and make the volume to 500 ml.

c) Zinc acetate solution (2N)

Dissolve 21.9 gm of crystallized zinc acetate [Zn(C2H3O2).H_2O] in distilled water add 3 ml of acetic acid and make up the volume to 100 ml.

d) Potassium Ferrocyanide (1N)

Dissolve 10.6 gm Potassium Ferrocyanide, $K_4Fe(CN)_6$.3H2O in distilled water and make upto 100 ml.

e) Acetic acid solution Equivalent to dilute NH3 strength.

f) Dil. aqueous ammonia solution (10%) 10 ml Conc.NH3, diluted to 100 ml.

g) Aqueous methylene blue indicator: 0.2% Dissolve 0.2 g of methylene blue in distilled water and make the volume to 100 ml.

h)Standard lactose solution (5%) Dissolve 5 gm lactose in distilled water and make the volume to 100 ml.

Procedure

a) Standardization of Fehling solution

Pipette out 5 ml of Fehling solution A and 5 ml of Fehling solution B in a 100-150 ml conical flask and mix. Take the standard lactose solution in a burette. Warm the contents in a conical flask over the burner and add a little less than expected amount of sugar solution and allow it to boil. Add a few drops of methylene blue. Now add drop wise the sugar solution from the burette till the blue color disappears and brick red color appears. By this method, determine the actual amount of standard solution utilized against 5 ml of aqueous solution.

b) Sample preparation

Weigh accurately 40 gm of sample in a 100 ml beaker, to that add 50 ml of hot water (30-90°C). Mix well. Transfer the contents to a 250 ml volumetric flask and rinse the beaker with hot water to make the volume to about 120-150 ml. Add 5ml of 10% dil. NH_3 solution, mix well for 10-15min. Add 5 ml of 10% acetic acid to neutralize ammonia (equivalent amount of glacial acetic acid). Add 12.5 ml of zinc acetate solution and 12.5 ml of Potassium Ferrocyanide solution to precipitate the proteins and mix well. Make up the volume to 250ml with distilled water. Filter through Whatman No.1. Discard some amount of filtrate and the rest is used for the titration.

Estimation of reducing sugar

Take 25 ml of this sample solution (filtrate), dilute it to 100 ml and titrate against 10 ml Fehling solution (5 ml Fehling A + 5 ml Fehling B).

Calculation

10 ml Fehling (A+B) solution = V1 ml of standard lactose sugar solution of concentrated C_1 mg/l 10 ml Fehling (A+B) solution = V2 ml of sample solution of Concentration C_2 Therefore,

$V_1C_1 = V_2C_2$ Therefore

$$C_2 = \frac{V1C1}{V_2} \text{ mg/ml}$$

$$C_2(\text{Lactose}) = \frac{V_1C_1 \times 250 \times 100}{V_2 \times 1000 \times 40 \times 25} \times 100\%$$

<u>Determination of Protein Contents in Milk and Milk Products by IDF and BIS Method</u>

Principle

The test portion is digested using a block-digestion or equivalent apparatus with a mixture of concentrated sulfuric acid and potassium sulfate, using copper (II) sulfate as a catalyst to convert organic nitrogen to ammonium sulfate. Addition of excess sodium hydroxide to the cooled digest liberates ammonia. The liberated ammonia is distilled, using either a manual or semi-automatic steam distillation and collected into an excess of boric acid solution followed by titration with hydrochloric acid solution. The nitrogen content is calculated from the volume of HCl used by ammonia in the titration and multiplied by 6.38 to get the corresponding crude protein content.

Chemistry of nitrogen determination

A. Solubilisation Stage

Proteins + H_2SO_4 + Na_2SO_4 or K_2SO_4 $\xrightarrow{Cu^{2+}}$ $(NH_4)_2SO_4$

B. Release of ammonia and steam distillation

$(NH_4)_2SO_4 + 2NaOH \rightarrow 2NH_4OH + Na_2SO_4$

NH_4OH Steam $\rightarrow NH_3 \uparrow + H2O \uparrow$

C. Collection of ammonia and back titration

$NH_3 + H_2O + H_3BO_3 \rightarrow NH_4H_2BO_3$

$NH_4H_2BO_3 + HCl \rightarrow NH_4Cl + H_3BO_3$

Conversion factor

Proteins in general vary in nitrogen content from 14 to 19% and thus a single universal conversion factor cannot be used. An average factor of 6.38 (corresponding to 15.65% N) is commonly used for milk proteins to convert nitrogen to protein.

Sample size

The protein content of different types of milk and milk products varies so for determination of total protein content by Kjeldahl method the size of sample varies such that the test portion sample should contain 0.2 to 0.4 g of protein.

Apparatus

Water bath; Analytical balance; Digestion block; Digestion tube, 250 ml capacity; Exhaust manifold; Aspirator; Automatic pipettes (dispensers); Graduated measuring cylinder 50 ml capacity; Distillation unit; Conical flask 250 ml capacity; Burette 25 ml capacity.

Reagents

- Kjeldahl catalyst mixture (Digestion mixture):
- It consists of 3.5 g potassium sulfate and 0.105 g copper sulfate. • Sulfuric acid: with a mass fraction of at least 98% nitrogen free.
- Sodium hydroxide solution: Nitrogen free, containing approximately 40 g sodium hydroxide per 100 ml.
- Boric acid solution: Dissolve 40 g of boric acid in 1 litre of hot water in a 1000 ml one-mark volumetric flask. Allow the contents to cool to 20°C and adjust the mark with water.
- Indicator solution: Dissolve 0.25 g of methylene blue and 0.375 g of methyl red in 300 ml of 95 per cent ethanol.
- Hydrochloric acid 0.1N
- •Tryptophan or lysine hydrochloride, minimum assay 99% (mass fraction).
- Sucrose, with nitrogen content not more than 0.002%.

Procedure

Preparation of test sample

Warm the test sample to between 38°C to 40°C in the water bath. Cool the sample to room temperature, while gently mixing the test sample immediately prior to weighing the test portion. 9

Test portion and pre-treatment

To a clean and dry digestion tube, add 5 g of digestion mixture. Weigh 2 g of test sample to the nearest 0.1 mg into the tube. Carefully add 10 ml of sulfuric acid along the sides of the digestion tube. Gently mix the contents of the tube and then leave to stand for 10 min.

Digestion

Set the digestion block at a low initial temperature so as to control foaming (approximately 180°C). Transfer the tubes to the digestion block and place the exhaust manifold which is itself connected to a water jet pump in the top of the tube. The suction rate of the water jet pump should be just sufficient to remove fumes. Digest the sample until white fumes develop. Then increase the temperature of digestion block to between 410°C and 430°C and continue digestion of the sample until the digest is clear. After the digest clears (clear with light blue-green color), continue digestion at between 410°C and 430°C for at least 1 h. During this time the sulfuric acid should be boiling. If visible boiling of the clear liquid is not apparent as bubbles forming at the surface of the hot liquid around the perimeter of the tube, then the temperature of the block may be too low. The total digestion time will be between 1.75 h and 2.5 h. At the end of the digestion, the digest shall be clear and free from undigested material. Remove the tube from the block with the exhaust manifold in place. Allow the digest to cool to room temperature over a period of approximately 30 min. The cooled digest should be liquid with a few small crystals at the bottom of the tube. Excessive crystallization indicates too little residual sulfuric acid at end of the digestion and may cause a decrease in protein estimation results. To reduce acid loss during digestion, reduce aspiration rate. After the digest has cooled to room temperature in approx. 30 min, remove the exhaust manifold and carefully add 50 ml of water to each tube. Swirl to mix while ensuring that any separated out crystals are dissolved. Allow the contents of the tube to cool to room temperature again.

Distillation

Transfer the digestion tube to the distillation unit and place a conical flask containing 50 ml of boric acid solution under the outlet of condenser in such a way that the delivery tube is below the surface of the excess boric acid solution and run the programme for automatic distillation Adjust the distillation unit to dispense 60 ml of sodium hydroxide solution and distill off the ammonia liberated by the addition of sodium hydroxide solution. Following the manufacture's instructions, operate the distillation unit in such a way as to steam distil the ammonia liberated by addition of sodium hydroxide solution, collecting the distillate in the boric acid solution containing mixed indicator. Continue with the distillation process until at least 150 ml of distillate is collected. Remove the conical flask from the distillation unit and completely drain the distillation tip. Rinse the inside and outside of the tip with water, collecting the rinsing in the conical flask. Always rinse the tip with water between samples.

Titration

Titrate the contents of the conical flask with the 0.1N hydrochloric acid using a burette and read out the amount of titrant used. The end point is reached at the first appearance of violet color in the contents.

Blank test

Carry out a blank test following the procedure described above taking 5 ml of water and about 0.85 g of sucrose instead of test portion.

Recovery tests

The accuracy of the procedure should be checked regularly by means of recovery tests as given below:

a) Check that digestion and distillation procedures are efficient by using a test portion of 0.06 g of lysine hydrochloride or 0.08 g of tryptophan weighed to the nearest 0.1 mg.

b) Determine the nitrogen content according to the procedure described above. The expected nitrogen content is 15.33% in lysine and 13.72% in tryptophan (the nitrogen recovery should be (98.5% to 101%).

c) Prepare a solution of ammonium sulphate of concentration 0.05 mol/L exactly. Pipette a 10 ml aliquot of the ammonium sulphate solution into the digestion tube and add 50 ml of water. Determine the nitrogen content of the solution according to the procedure described above. (nitrogen recovery should be 99% to 101%).


Kjeldahl Apparatus

Calculation

Calculate the nitrogen content, Wn, by using the following equation:

$$Wn = \frac{1.4 \times (Vs-Vb) \times N}{m}$$

Where, Wn = is the nitrogen content of the sample, expressed as percentage by mass

Vs = is the numerical value of hydrochloric acid solution used in determination in millilitres, expressed to the nearest 0.05 ml

Vb = is the numerical value of the volume of hydrochloric acid solution used in the blank test in millilitres, expressed to the nearest 0.05 ml

N = is the numerical value of the exact normality of the hydrochloric acid solution expressed to four decimal places.

m = is the numerical value of the mass of the test portion in grams, expressed to the nearest 1 mg,

Calculate the crude protein content Wp using the following equation:

Wp = Wn x 6.38

where, Wp = is the crude protein content, expressed as a percentage by mass.

Wn = is the nitrogen content of the sample, expressed as a percentage by mass to four decimal places. = is the generally accepted multiplication factor to express the nitrogen content as crude protein content

BIS method

Apparatus

i) Digestion flask – Kjeldahl flask

ii) Distillation apparatus – Micro Kjeldahl distillation.

Steam is produced by boiling water in flask A, and this is bubbled through the solution in flask C. The distillate passes through the condenser D and can be collected at the end of the condenser. A trap B is provided between flasks A and C in such a way, that when A is cooled, the contents in C are sucked out into flask B which can then be discarded. There is also a funnel arrangement F provided to add samples directly to flask C.

Reagents

a. Concentrated sulfuric acid – approx. 98% by weight and nitrogen free (ρ=1.84 g/cm3)
b. Copper sulphate
c. Potassium sulphate or anhydrous sodium sulphate (nitrogen free)
d. Sodium hydroxide solution – 50% by wt.
e. Boric acid solution – saturated
f. Indicator solution – Mix equal volumes of a saturated solution of methyl red in ethanol (95% by vol.) and a 0.1% solution of methylene blue in ethanol (95% by vol.)
g. Standard hydrochloric acid – 0.02N

Preparation of test sample

Warm the test sample of milk between 38°C to 40°C in the water bath. Cool it to room temperature while gently mixing the test sample immediately prior to weighing the test portion.

Procedure

a) Digestion of sample

Transfer accurately weighed (approx.) 10 g sample of milk to a Kjeldahl flask. Add 10 g of potassium sulphate and 0.2 g copper sulphate. Add 25 ml of concentrated sulfuric acid, along the neck of the flask in such a way as to wash down any milk drops sticking to the side of the flask. Gently rotate the flask so that the whole of the contents are well mixed. Place the flask on a flame so that the neck is inclined at an angle of 45° to the horizontal and the bulb rests in the hole of an asbestos sheet so that the flame does not touch the flask above the level of the liquid. Heat initially to gentle boiling and when frothing has ceased, boil the contents of the flask briskly until clear and free from yellowish color and for a further period of one hour. Allow the liquid to cool and wash down the sides with a fine jet of distilled water. Continue heating the contents of the flask for a further period of one hour. Allow the liquid to cool to room temperature and make upto volume in a 100 ml volumetric flask.

b) Distillation

Pipette out 10 ml aliquot of the solution into the flask _C‘through the funnel of micro Kjeldahl distillation apparatus. Then add 8 ml of sodium hydroxide solution through funnel. Keep a flask containing 10ml of the boric acid solution containing 2-3 drops of the indicator, at the delivery end of the condenser in such a way that the tip is just beneath the surface of the liquid. Now heat the flask _A‘filled with water to produce steam. This steam is passed through the contents of flask _C‘. The ammonia evolved there by the alkaline treatment of digested sample is carried along with steam through the condenser outlet and is absorbed in boric acid solution. Continue passing steam for 10 minutes and collect about 50 ml of distillate, then remove the receiver flask after rinsing out the tip of the condenser. Stop heating flask _A‘. On cooling, this will create a back suction so that the contents in the flask _C‘ will be sucked into the trap _B‘. Add about 10 ml of water through the funnel quickly, so that it will also be sucked into flask _B‘, while rinsing flask _C‘. The apparatus is now ready for distillation of next sample. Titrate the contents in the receiver flask against the standard hydrochloric acid till the color changes from green to violet color. Note the volume of acid used. Carry out a blank determination by taking 0.5 g of sucrose in place of milk, and by using the same quantities of reagents and the same conditions of test.

c) Calculations

Crude protein is calculated by multiplying nitrogen content by the factor 6.38.

$$\text{Crude Protein (percent by weight)} = \frac{6.38 \times 1.4 \times (V2-V1)N \times DF(100/10)}{W}$$

Where, V2 = Number of ml of hydrochloric acid standard volumetric solution used in distillation

V1 = Number of ml of hydrochloric acid standard volumetric solution used in the blank test

N = Normality of hydrochloric acid standard volumetric solution

W = Weight in g of the sample taken for analysis

DF = dilution factor

Total ash content

Principle

Milk contains soluble salts like sodium, potassium, calcium, phosphorus, citrates, sulphates, chlorides, carbonates, magnesium etc. Heating milk at higher temperatures decomposes organic matter and the soluble inorganic salts are left in the form of ash.

Requirements

Single pan balance, muffle furnace, desiccator, silica crucible, tong, hot plate.

Procedure

Accurately weigh 10 g of milk sample in to the silica crucible. Evaporate the sample to dryness on a hot plate. Place the crucible in a pre-heated muffle furnace and heat the contents at 550°C until ash is free from carbon. Cool the crucible by placing in desiccator. Weight the crucible containing the ash. Continue heating, cooling and weighing until the difference in weight is not more than 0.1 gm.

Calculations

Weight of empty crucible = W g
Weight of crucible with milk = W1 g
Weight of crucible after drying = W2 g
Weight of milk sample = W1– W g (A)

Weight of ash = W2 – W g (B)

$$\text{Percent Ash by weight} = \frac{B \times 100}{A}$$

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CENTRAL FACILITY OF SOPHISTICATED INSTRUMENTS FOR FOOD ANALYSIS

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Central Instruments laboratory (CIL) of CoVAS, Mannuthy is the central facility with state-of-the art analytical instruments to fulfill the needs of the faculty and research scholars and is well equipped with high end sophisticated instruments. The facilities are extensively used by post graduate as well as doctoral research scholars. This facility is also extended to external organizations, mainly academic institutions in and around of the region at nominal rates.

A brief description about some of the sophisticated instruments in the CIL is given below.

1. **Gas Chromatography/Mass Spectrometry (GC/MS/MS)**

The Gas Chromatography/Mass Spectrometry (GC/MS) instrument separates chemical mixtures (the GC component) and identifies the components at a molecular level (the MS component). It is one of the most accurate tools for analyzing environmental samples.

The GC works on the principle that a mixture will separate into individual substances when heated. The heated gases are carried through a column with an inert gas (such as helium). As the separated substances emerge from the column opening, they flow into the MS. Mass spectrometry identifies compounds by the mass of the analyte molecule from the inbuilt library of known mass spectra, covering several thousand compounds, is stored on a computer. Mass spectrometry is considered the only definitive analytical detector.

Applications of GC-MS-MS include pesticide analysis, drug detection, fire investigation, environmental analysis, explosives investigation, and identification of unknown samples.

2. **Liquid Chromatography/ Mass Spectrometry(LC-MS)**

High-performance liquid chromatography (HPLC), formerly referred to as high-pressure liquid chromatography, is a technique in analytical chemistry used to separate, identify, and quantify each component in a mixture. It relies on pumps to pass a pressurized liquid solvent containing the sample mixture through a column filled with a solid adsorbent material. Each component in the sample interacts slightly differently with the adsorbent material, causing different flow rates for the different components and leading to the separation of the components as they flow out of the column.

The LC-MS technology involves use of an HPLC, wherein the individual components in a mixture are first separated followed by ionization and separation of the ions on the basis of their mass/charge ratio. The separated ions are then directed to a photo or electron multiplier tube detector, which identifies and quantifies each ion. The ion source is an important component in any MS analysis, as this basically aids in efficient generation of ions for analysis. To ionize intact molecules, the ion source could be APCI (Atmospheric Pressure Chemical Ionization), ESI (Electronspray Ionization), etc. The choice of ion source also depends on the chemical nature of the analyte of interest i.e. polar or non-polar. The major advantages of this technology include sensitivity, specificity and precision as analysis is done at molecular level.

HPLC has many applications in both laboratory and clinical science. It is a common technique used in pharmaceutical development, as it is a dependable way to obtain and ensure product purity. The coupling of MS with LC systems is attractive because liquid chromatography can separate delicate and complex natural mixtures, which chemical composition needs to be well established (e.g., biological fluids, environmental samples, and drugs). Other important applications of LC-MS include the analysis of food, pesticides, and plant phenols and toxins.

3. **Atomic absorption spectroscopy (AAS)**

The absorption of light by atoms provides a powerful analytical tool for both quantitative and qualitative analysis. Atomic absorption spectroscopy (AAS) is based upon the principle that free atoms in the ground state can absorb light of a certain wavelength. Absorption for each element is specific; no other elements absorb this wavelength. The total amount of absorption depends on the number of free atoms present and the degree to which the free atoms absorb the radiation. At the high temperature of the AA flame, which may be either oxy-acetylene or nitrous oxide/acetylene, the sample is broken down into atoms and it is the concentration of these atoms that is measured.

AAS is a single-element method used for trace metal analysis of e.g., biological, metallurgical, pharmaceutical and atmospheric samples. AAS is used in food and beverage, water, clinical, and pharmaceutical metal analysis. It is also used in mining operations, such as to determine the percentage of precious metal in rocks.

4. **Inductively Coupled Plasma Optical Emission Spectrometry (ICP OES)**

ICP, abbreviation for Inductively Coupled Plasma, is one method of optical emission spectrometry. When plasma energy is given to an analysis sample from outside, the component elements (atoms) is excited. When the excited atoms return to low energy position, emission rays (spectrum rays) are released and the emission rays that correspond to the photon wavelength are measured. The element type is determined based on the position of the photon rays, and the content of each element is determined based on the ray’s intensity.

Compared to atomic absorption spectrophotometers, in which the excitation temperature of air-acetylene flame measures 2000 to 3000 K, the excitation temperature of argon ICP is 5000 to 7000 K, which efficiently excites many elements. Also, using inert gas (argon) makes oxides and nitrides harder to be generated. Application of ICP-OES includes the determination of metals in wine, in food, and trace elements bound to proteins.

5. **Fourier-transform infrared spectroscopy (FTIR)**

Fourier-transform infrared spectroscopy (FTIR) is a technique used to obtain an infrared spectrum of absorption or emission of a solid, liquid or gas. An FTIR spectrometer simultaneously collects high-resolution spectral data over a wide spectral range.

FTIR spectrometers rely on the fact that many gases absorb IR radiation at species-specific frequencies. However, FTIR spectroscopy is a disperse method, which means that measurements are performed over a broad spectrum instead of a narrow band of frequencies.

Rather than shining a monochromatic beam of light (a beam composed of only a single wavelength) at the sample, this technique shines a beam containing many frequencies of light at once and measures how much of that beam is absorbed by the sample. Next, the beam is modified to contain a different combination of frequencies, giving a second data point. This process is rapidly repeated many times over a short time span. Afterwards, a computer takes all this data and works backward to infer what the absorption is at each wavelength. Fourier transform infrared spectroscopy – attenuated total reflectance (FTIR–ATR) provides information related to the presence or absence of specific functional groups, as well as the chemical structure of polymer materials.

FTIR spectroscopy is used to quickly and definitively identify compounds such as compounded plastics, blends, fillers, paints, rubbers, coatings, resins, adhesives and adulterants. It can be applied across all phases of the product lifecycle including design, manufacture, and failure analysis.

6. Scanning electron microscope

A scanning electron microscope (SEM) is a type of electron microscope that produces images of a sample by scanning the surface with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that contain information about the surface topography and composition of the sample. The electron beam is scanned in a raster scan pattern, and the position of the beam is combined with the intensity of the detected signal to produce an image. In the most common SEM mode, secondary electrons emitted by atoms excited by the electron beam are detected using a secondary electron detector. The number of secondary electrons that can be detected, and thus the signal intensity, depends, among other things, on specimen topography.

Because of its great depth of focus, a scanning electron microscope is the EM analog of a stereo light microscope. It provides detailed images of the surfaces of cells and whole organisms with a maximum of one lakh magnification that are not possible by TEM. It can also be used for particle counting and size determination.

CHEMICAL CONTAMINANTS IN MILK AND MILK PRODUCTS

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Introduction:

Animals may become exposed to various chemical substances during their production cycle. Milk, a highly perishable commodity is susceptible to contamination not only with microorganisms but also with chemical residues which include residues of pesticides, antibiotics, hormones and heavy metals. The milk may also get contaminated with use of adulterants, preservatives, neutralisers and disinfectants. Proper elucidation of the spectra and levels of chemical contaminants in milk is necessary to understand their interactions with other components in milk. As milk is consumed more by the vulnerable group which includes infants, young children and the elderly, the concentration of these residues should be kept as low as possible. In order to safeguard human health, the Food Safety and Standards Authority of India has formulated maximum residue limits (MRL) for these residues in foods.

Drug residues:

Drug residues are small amounts of drugs or their active metabolites, which remain in milk or meat after treating the animals. Antibiotics have been used for treatment, prophylaxis and also as growth promoters in veterinary practice. The main reasons for the presence of antibiotic residues in animal foods include indiscriminate use, misuse and non -adherence to withdrawal period. Antibiotics are often used in animals for treatment of various diseases. In lactating cattle, they are used in dry cow therapy and mastitis treatment in which may cause the presence of antibiotic residues in milk. Anthelmintic drugs are also used for treatment of various parasitic diseases leading to formation of their residues in milk and meat. The veterinary drugs are administered to animals by many routes such as intravenous, intramuscular routes, orally in the food and water, topically on the skin and by intra mammary and intrauterine infusions. All of these routes may lead to residues appearing in milk and dairy products and are usually detectable in the milk for a few days after the last treatment. Hence, observing the withdrawal period of milk before consumption is very important. Withdrawal periods of some common antibiotics is shown in Table 1.

Table -1 Withdrawal periods of some common parentrally used antibiotics

S. No.	Drug	Milk discard (hr)
1.	Amoxycillin	96
2.	Cloxacillin	84
3.	Ampicillin	48
4	Streptomycin	48-78
5	Neomycin	72
6	Dihydrostreptomycin	48
7	Erythromycin	72
8	Procaine Penicillin	72
9	Sulfamethazine	96
10	Sulfaethoxypyridizine	72
11	Sulfabromomethazine	96

12	Sulfonamides + TMP	72
13	Gentamicin	60
14	Tylosin	96
15.	Thiabendazole	96

The Food Safety and Standards (Contaminants, Toxins, and Residues) Amendment Regulations, 2018 specifies the tolerance limits of antibiotics and other veterinary drugs in meat/meat products, poultry, fish, and milk.

In the dairy industry the presence of these drug residues leads to interference with starter metabolism, inhibition of lactic acid production, off flavours, poor quality product and economic loss. Consumption of foods of animal origin containing antimicrobial residues may cause development of direct and indirect toxicity, side effects such as hypersensitivity, injury to liver, discolouration of teeth and gastrointestinal disorders in human beings (FAO/WHO, 2002). Low levels of antimicrobial exposure results in alteration of microflora, and there is concern about transfer of antimicrobial resistant pathogens through the food chain. Resistant strains can cause failure of antimicrobial therapy in clinical situations in future. Penicillin residues in milk could provoke allergic reactions in sensitized individuals. Exposure to chloramphenicol residues in foods can rarely cause a fatal blood dyscrasia in individuals Some of the pathological effects caused by antimicrobial residues in human beings through foods include immune pathological effects, hypersensitivity reactions, cancer (Sulphamethazine, Oxytetracycline, Furazolidone), mutagenicity, nephropathy (Gentamicin), hepatic disorders, reproductive disorders, myelotoxicity (Chloramphenicol).

Effects of different processing practices on antimicrobial residues in food animal tissues are influenced by the combination of time and temperature. Tetracyclines show notable decrease in their residue level in food animal tissues after cooking which gives a marginal safety to consumers. Nitrofurazones are more stable. Cooking methods cannot totally eliminate antimicrobial residues from foods, but it can possibly decrease their amounts.

Methods of detection of antibiotic residues:

The commonly used methods for detection of antibiotic residues in milk include high-performance liquid chromatography (HPLC), gas chromatography coupled to mass spectroscopy (CG-MS), and antimicrobial detection kits.

Strategies for control of drug residues:

a. India has regulations on antibiotic use in food animals but implementation and compliance should be more stringent.
b. Observing good husbandry practices can result to less clinical diseases and reduced need for antibiotic use in animals.
c. Practices that increase animal production without reliance on non-therapeutic use of antibiotics need to be explored. With the AMR problem, phyto chemicals can be alternatives to antibiotic use
d. Strategies to reduce over-the-counter sales of drug access
e. Awareness on drug residues and its effects among farmers including knowledge on withdrawal periods**.**

Pesticide residues:

Contamination of feeds arises in the field or store where treatment with pesticides occurs. Chlorinated pesticides and related compounds such as Dichlorodiphenyltrichloroethane (DDT), Dichloro diphenyl dichloroethane (DDD), Polychlorinated biphenyls (PCBs), chlorinated cyclodienes (aldrin, dieldrin, heptachlor, etc.), the hexachlorocyclohexanes (lindane) and dioxins can enter milk and dairy products when the cow consumes contaminated feed. The chlorinated hydrocarbons are extremely durable, persistent, endocrine disrupting activities, bio accumulating and widely distributed toxic compounds that find their way into the food chain usually through use in controlling environmental or animal pests. As much as 20% of an ingested chlorinated hydrocarbon excretes in milk. Chlorinated hydrocarbons adhere to milk fat and butter contains a much higher proportion of these insecticides. The DDT can accumulate in fatty tissues and can transfer into milk and dairy products. Organochlorine pesticides such as DDT and hexachlorocyclo hexane (HCH) have banned in many countries. Residues of such compounds may persist in the environment and cause contamination through the food chain. The MRL values of notified under Food Safety and Standards (Contaminants, Toxins and Residues) Regulations 2011

HEALTH HAZARDS OF PESTICIDES:

Pesticides can present danger to consumers, bystanders or workers during manufacture, transport or during and after use. Pesticides have been linked to a myriad of diseases. Remnants of Kerala Veterinary and Animal Sciences University 32 pesticides have been found in blood stream of sufferers of certain types of cancer. Particular uncertainty exists regarding the long-term effects of low-dose pesticide exposure. Health risks associated with pesticide use include immunopathological effects *viz.*, Acquired Immunodeficiency, Autoimmunity , Hypersensitivity, Carcinogenic effects, Mutagenicity , Teratogenicity , Neuropathy, Nephropathy, Hepatotoxicity, and Reproductive disorders.

DETECTION OF PESTICIDE RESIDUES:

At present, gas chromatography (GC) is the most widespread method for the separation and determination of most pesticides. However, liquid chromatography (LC) is also used for measuring levels of some pesticide residues such as carbamates and triazines, in foods of animal origin. Liquid chromatography (LC) is used for the analysis of polar and/or non-volatile and/or thermally labile pesticides for which GC conditions are not suitable, mainly carbamates and triazines, and their metabolites and degradation products.

STRATEGIES TO COMBAT PESTICIDE RESIDUES:

1. The farmers should be advised about the harmful effects of pesticides so that they would judiciously use them both in terms of quantity and frequency.
2. It should be assured that the pesticides produced in a country should be distributed proportionately so that the indiscriminate and disproportionate use can be avoided.
3. All emphasis must be laid on the development of bio-pesticides like viral, bacterial or fungal pesticides or pesticides of botanical origin like neem or tulsi, which can be used on crops to kill the insect pests without polluting the environment.
4. The production, import or use of harmful pesticides like some organochlorines, organophosphates and carbamates must be banned strictly in India.
5. Some herbal preparations should be developed which can overcome the immunopathological, neuropathic or nephropathy effects of pesticides on human body.

Heavy Metals:

Heavy metals are naturally occurring elements that have a high atomic weight and a density at least 5 times greater than that of water. Their multiple industrial, domestic, agricultural, medical and technological applications have led to their wide distribution in the environment; raising concerns over their potential effects on human health and the environment. Their toxicity depends on several factors including the dose, route of exposure, and chemical species, as well as the age, gender, genetics, and nutritional status of exposed individuals. Because of their high degree of toxicity, arsenic, cadmium, chromium, lead, and mercury rank among the priority metals that are of public health significance. Metals can also occur as residues in food because of their presence in the environment, Humans can be exposed to these metals from the environment or by ingesting contaminated food or water.

Sources of heavy metals milk

Due to continuous industrialization and urbanization activities, heavy metal pollution becomes a major cause of environmental degradation. Heavy metals are commonly found in nature and their concentrations in food items are increasing day by day as a result of utilization of untreated sewage water and industrial effluents for irrigation of crops. Among different metals, it was suggested that Cd would be the most mobile element in the soil and more available to crop. Industrial emissions of contaminant to the atmosphere which is finally deposited on soil or dumping of industrial wastes on disposal land may cause problem in the environment beyond limit. In India, many urban and dense cities with significant industrial waste generation have been found to have contaminated soil. Metals may contaminate animal milk through instruments and machinery used in processing and distribution of milk. For this reason, processed milk is reported to have higher concentrations of heavy metals as compared to raw milk. Furthermore, heavy metals may also enter into milk through contaminated animal feed by the routes of irrigation with polluted canal or sewage water, the application of pesticides and fungicides, and the presence of industries near the animal feed areas. Research on the effect of environmental pollution on the heavy metal content of raw milk conducted by scientists revealed that higher heavy metal concentration in the milk from areas in proximity to industrial zones and areas with significant vehicular traffic while lower heavy metal concentrations in the milk samples from rural areas. Hence, heavy metal concentration in milk can act as an indicator of environmental pollution

Harmful Health Effects:

Heavy metals have been reported to affect cellular organelles and components such as cell membrane, mitochondrial, lysosome, endoplasmic reticulum, nuclei, and some enzymes involved in metabolism, detoxification, and damage repair. Metal ions have been found to interact with cell components such as DNA and nuclear proteins, causing DNA damage and conformational changes that may lead to cell cycle modulation, carcinogenesis or apoptosis .Several studies have demonstrated that reactive oxygen species (ROS) production and oxidative stress play a key role in the toxicity and carcinogenicity of metals such as arsenic, cadmium, chromium, lead, and mercury. Because of their high degree of toxicity, these five elements rank among the priority metals that are of great public health significance. They are all systemic toxicants that are known to induce multiple organ damage, even at lower levels of exposure. According to the United States Environmental Protection Agency (U.S. EPA), and the International Agency for Research on Cancer (IARC), these metals are also classified as either "known" or "probable" human carcinogens based on epidemiological and experimental studies showing an association between exposure and cancer incidence in humans and animals.

Strategies for control:

a. The treatment of industrial waste water by adsorption of heavy metals from industrial waste water can prevent the contamination of water bodies. Some potentially low-cost sorbents for heavy metals have been found effective, including sorbents that are waste products of some industrial processes In general, a widely used treatment technique is chemical precipitation using hydroxides. More advanced treatment technologies such as Nano-Filtration (NF), Reverse Osmosis (RO), and Ion Exchange have also been found to be effective

b. The water used for drinking of animal and the fodder of milking animal should be regularly monitored to evaluate the level of heavy metals.
c. Precautions should be taken to avoid metal contamination during the handling, processing, and storage of milk and milk products, and only food grade materials should be used during these steps.
d. Animal herds and the land used for the cultivation of animal fodder should be selected far from the industrial and heavy traffic areas to avoid the chances of metal contamination.
e. The practice of heavy metal detection should be continued to avoid possible contamination.
f. It is also essential that farmers should be educated to reduce such contamination and should be encouraged to use the controlled amount of pesticides to avoid the leaching of waste water and cultivation should be conducted in fields far away from industrial area as well as areas prone to contamination.

Milk Adulterants, Preservatives and Neutralisers:

Milk adulteration, poor hygiene, malpractices, lack of preservation technology, refrigeration facilities and sanitation conditions contribute to the poor quality of raw milk. Water is the most widely added adulterant to increase milk production, but it is a major health issue for the milk consuming population if polluted water is added to milk. Urea is added to milk to increase non-protein nitrogen content and solid-not-fat (SNF). Melamine is an adulterant which when added especially to infant milk powders can be very hazardous. It is added to raise the protein content of the milk and milk powder. It can cause kidneys failure and in extreme cases deaths. Detergents are added that give a frothy solution and give a characteristic white colour to milk. Gastro-intestinal complications are often associated with consumption of detergent contaminated milk. Peroxides of hydrogen (H_2O_2) helps to prolong its freshness but peroxides harm the gastrointestinal cells which can lead to gastritis and intestinal inflammation. Starch is used to raise solid-not-fat (SNF) content of milk, and if large levels of starch are added to milk, the effects of undigested starch in the colon may cause diarrhoea. Chlorine is added to compensate for the density of the diluted milk. Chlorinated milk can cause arterial clogging and cause heart attacks. The acid base balance in the body and even the blood pH are disrupted by chloride in the milk. Sugar is generally mixed in the milk to increase the solids not fat content of milk to increase the lactometer reading of milk, which was already diluted with water. Low valued Milk when combined with higher valued milk, milk is adulterated. Goat milk, for example, is frequently adulterated with cow milk for greater benefit. Whey addition is done to raise the amount of milk. Low-priced rennet whey sometimes blends with liquid milk and milk powder. The addition of solid rennet whey to UHT milk causes blood pressure to decrease. For greater benefit, some businessmen use inexpensive muriatic acid to prepare whey, which causes severe health problems. In synthetic milk, NaOH is often used to neutralise the acidic effect. In India synthetic milk is a common problem that is prepared by adding urea, caustic soda, refined oil and common detergents. For those suffering from hypertension and heart ailments, caustic soda contains sodium and serves as a slow poison. Caustic soda deprives the body of the use of lysine, an essential amino acid in milk Often several food colouring agents are introduced to enhance appearance and have dangerous health effects. The addition of preservatives is followed to increase the shelf life of milk. The milk can be protected for a long time by boric acid, formalin, sodium carbonate (Na2CO3), sodium bicarbonate (NaHCO3), salicylic acid, benzoic acid etc. These substances can induce stomach pain, diarrhoea, vomiting and other symptoms associated with poisoning.

Conclusion:

The presence of these chemical contaminants in foods is an area of concern as they cause serious health effects. In India, implementation and enforcement of the Food Safety and Standards Act (FSS) needs to be strengthened and training, education and awareness of all stakeholders should be a priority. Incentives should be given to farmers for production of safe food which will further safeguard consumer health.

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MICROBIOLOGICAL QUALITY AND SAFETY OF MILK AND MILK PRODUCTS

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Milk safety and quality assurance has become an area of priority and necessity for consumers, producers and regulators. Milk quality refers to a combination of characteristics that enhance the acceptability of the milk and milk product. Quality relates to chemical, physical, technological and bacteriological characteristics of milk and milk products. The components of milk and its physical and chemical properties provide a favorable atmosphere for the growth and multiplication of microorganisms, thus causing milk spoilage and transmission of disease in humans. Changing global patterns of dairy food production, international trade and public prospects for health protection have created a demand for food safety. The sources of microbial contamination during collection of raw milk, processing pasteurized milk, knowing the effect of pasteurization and predicting the shelf life and sensory attributes of refrigerated pasteurized milk and the quality of market milk sold in retail outlets need to be studied thoroughly.

Microbiological quality of raw milk

Milk is a medium with high concentration of nutrients and hence provides an ideal environment for microbes. Lack of hygiene at the level of production adds different kinds of undesirable microorganisms to milk, which will multiply under favorable temperature bringing about either spoilage of milk or make milk unsafe for consumption. The contamination of milk with spoilage or pathogenic microorganisms can occur at any stage of milk production, processing, marketing and utilization. Pathogenic microorganisms may gain entry into milk from various sources and may produce diseases in consumers. Beneficial group of microorganisms are also present in milk of which some of them are used as starters for the preparation of a variety of fermented products. Extent of microbial contamination and subsequent multiplication in milk directly determines the microbiological quality of milk and dairy products. Hence the microbiological quality of milk needs to be monitored regularly. Good-quality raw milk should be free of debris and sediment, free of off-flavours and abnormal colour and odour, low in bacterial count, free of chemicals and of normal composition and acidity. The quality of raw milk is the primary factor determining the quality of milk products.

Cold storage and growth of psychrotrophic bacteria

Storage of raw milk for long periods at low temperature has brought about new quality problems for the dairy industry. These problems are related to the growth and metabolic activities of microorganisms at low temperatures. These microorganisms are termed psychrotrophs and are common contaminants of milk. Although conventional psychotropic bacteria are heat labile, the metabolites of bacteria or enzymes like lipases and proteinases released by psychrotrophic bacteria may remain functional even after heat treatment. Once these enzymes have been secreted, they have the potential to degrade both raw and processed milk components. There are a variety of psychotropic organisms, including *Pseudomonas fluorescens.*

Milk spoilages

It has been common knowledge that if milk is left at room temperature, it would spontaneously sour as a result of the growth of a major component of lactic acid bacteria present in the milk. Milk can become contaminated by a large variety of spoilage microorganisms from many contamination sources, which include the feed, the barn environment (air, water), the cow's udder, milking equipment and milker. The concept of milk quality relates to the amount and types of spoilage bacteria present in the milk. One is to attempt to minimize the bacterial load by preventing contamination throughout the dairy chain (Boor *et al*., 2017). Effective temperature control from the time of milking to storage is essential. The microbial count is one the most important quality indicators that directly affect the milk quality. Rapid platform tests are performed to reject the poor quality milk at collection centres to prevent the mixing of poor quality milk with good quality milk.

Safety of milk

According to the Food and Drug Administration, raw milk can support the growth of dangerous microorganisms, such as Salmonella, *E. coli* and Listeria, which can cause serious health risks to human. Because there is a risk of pathogen contamination in milk produced from healthy cows under sanitary milk conditions, pasteurization of milk prior to consumption will destroy pathogens and provide protection from illness associated with consumption of dangerous microbes. Occasionally, human illness has been linked to pasteurized milk products but these cases usually have been a result of contamination of the product after pasteurization or improper pasteurization.

Processed milk quality and safety

In human population raw milk and dairy products are often causes food-borne disease outbreaks. Occasionally pasteurized milk may be contaminated due to improper handling and storage after pasteurization and lead to bacteria spoilage of milk during the dairy processing with a potential health risk for the consumers. Milk pasteurization was introduced as a public health measure in order to destroy human pathogens and to eliminate or reduce the activities of spoilage microorganisms. Pasteurization systems are designed to provide a 5 log reduction of the microbial load using the most thermo tolerant target pathogen *Coxiella burnetii*. With pasteurization, not only are pathogenic microorganisms killed but also a wide range of spoilage organisms are destroyed. Typical pasteurization conditions should be as follows: Not less than 62.8^{0}C for at least 30 min (holder method) or not less than 72^{0}C for at least 15 s (HTST). Bactofugation is another method used in the removal of bacteria and spores from raw milk. During bactofugation, milk is separated into two parts, namely, clean milk (microorganisms-free milk) and bactofugate which is rich in bacteria and spores. Generally, the bactofugation efficiency ranges between 98% and 99.5% for spores. Other methods, like high hydrostatic pressures, addition of carbon dioxide to raw milk, microwave heating, radio frequency heating, pulsed electrical field, and ohmic heating are not in common use at the industrial level.

Human health associations with pathogenic bacteria

Milk and milk products may carry organisms as such or their toxic metabolites (poisons) called toxins. Organisms from human carriers, the environment, milk-producing animals, or other animals have been agents of milk borne disease such bovine tuberculosis,brucellosis,anthrax,salmonellosis,listeriosis,leptospira infection, Q fever, foot and mouth disease, toxoplasmosis and hypersensitivity reactions. Contamination of milk by human beings can cause Septic sore throat and, diphtheria, typhoid fever, paratyphoid fever, infectious hepatitis, polio infection, enteritis and amoebiasis. Contamination of milk from environment may result in botulism and *E.coli* infection.

In the past 20 years, food borne illnesses from dairy product consumption have been predominantly associated with *Salmonella enterica*, *Listeria monocytogenes*, *Campylobacter jejuni*, and *Escherichia coli* O157:H7. These organisms have been isolated from bulk tank samples (Jayarao *et al.*, 2006). Because there is a risk of pathogen contamination in milk produced from healthy cows under sanitary milk conditions, pasteurization of milk prior to consumption will destroy pathogens and provide protection for illness associated with consumption of dangerous microbes. Occasionally, human illness has been linked to pasteurized milk products but these cases usually have been a result of contamination of the product after pasteurization or improper pasteurization. If pathogenic microorganisms are not removed by pasteurisation, consumption of these products can represent a serious health risk. These pathogens can originate from the mammary gland or associated lymph nodes of cows suffering from systemic diseases or infections or from equipment, raw milk tankers and personnel. Ingestion of these microorganisms can lead to illnesses of varying severity. Typical symptoms of food poisoning can include fever, nausea, vomiting, diarrhoea and abdominal pains; in extreme cases, death can occur. Regardless of the frequency at which they are present, these pathogens can impact, in some instances severely, on health. *Staphylococcus aureus* can be transferred to milk through the teat canal, equipment, the environment or human handling and cause illness through the production of heat-stable enterotoxins, which can withstand pasteurisation. *Coxiellaburnetii*, the causative agent of Q fever, can infect many animal species, and it is thought that its association with cows, sheep and goats is the main source of human infection. Of the milk-borne pathogens, *L. monocytogenes, Yersinia enterocolitica* and Brucella spp. are a particular cause for concern. They are able to survive and multiply at refrigeration temperatures and may cause severe diseases. *Yersinia enterocolitica* is a major cause of acute gastroenteritis. The symptoms of illness can include diarrhoea, abdominal pain and fever. Thus, it is important to implement a hygiene system that begins at the farm level and includes a focus on cow health and hygiene, equipment cleanliness, overall farm and personnel sanitation, correct storage and subsequent processing of milk.

Fungal populations

Yeasts and moulds can also be important microbial populations within raw milk. The fungal composition of raw milk can be influenced by the physiological state of the animal, as well as the weather, feeding and season. As with bacteria, the extent of the fungal population in raw milk and dairy products is often underestimated. Mycotoxins, that is, low molecular weight compounds produced as secondary metabolites by filamentous fungi, can lead to illness in humans with symptoms such as nausea, vomiting, diarrhoea and headache. The aflatoxin M1 contamination levels in milk appear to be a serious health hazard derivate from hepatotoxic and carcinogen effects of aflatoxin M1, which show a high risk on milk safety. The milk contamination risk is established through the forages, corn and concentrated feeds; those are contaminated by aflatoxin B1 (AFB1). Regulatory limits are imposed to watch over the limit exposure to aflatoxins in dairy.

Bacteriological standards for raw and pasteurized milk

Food Safety and Standards Act (2006) prescribes microbiological limit/standards for milk and dairy products. In many countries, processors and cooperatives have established price incentives or premium payment for raw milk with a low bacteriological load. Countries have developed their own standards that are considered in premium payment for milk. All these standards mandate the production of milk with as low bacteriological load as possible. The aerobic plate count or the total viable count, also known as standard plate count (SPC) is one of the most common tests applied to indicate the microbiological quality of food (ICMSF, 1978). The viability of bacteria in milk after heat treatments can be assessed by using viability indicators, colony forming unit (CFU) on plate count agar. The level of Enterobacteriaceae and *E. coli* (total) are crucial criteria to monitor processing hygienic conditions. The coliform count is widely used to determine the total number of coliforms present in milk samples. Evaluation of microbiological criteria in dairy products is indispensable step to ensure efficiency of HACCP plan.

Beneficial bacteria associated with raw milk.

Raw milk can contain a diverse bacterial population. Many such bacteria can contribute subsequently to natural fermentations. In some situations, specific strains have been so successful in this regard that they have been isolated from milk and consciously added as starters or adjuncts designed to confer desirable traits on fermented products. Health-promoting bacteria isolated from these beverages and other sources are commonly referred to as 'probiotics', that is, 'live bacteria which when administered in adequate amounts confer a health benefit on the host' (FAO/WHO, 2002). The selection of such bacteria for commercial probiotic application relies on criteria relating to safety, technological and digestive stress survival, intestinal cell adhesion, and human origin.

Milk products quality and safety

Dairy products are an evergreen favorite of people all over the world. Annually, hundreds of people all over the world are getting poisoned with these products because of contamination either of raw materials, or equipment or final products in the production process, transportation and distribution and non-observance of good manufacturing practices (GMP) by workers. Pathogens causing food borne outbreaks that associated with the consumption of milk and dairy products include *E. coli* O157:H7, *Staphylococcus aureus, Cl. botulinum, Bacillus cereus, Yersinia enterocolitica* and *Listeria monocytogenes*, they represent a major public health hazard, especially for persons who still drink raw milk and raw milk products. Presence of anaerobes in dairy products like cheese may be indicative of manure and soil contamination because of most of the anaerobic organisms normally grows in soil and water. Some species of the anaerobe *Clostridium* genus cause food-borne disease, the most well-known food-borne disease is botulism which is caused by *Clostridium botulinum* and food poisoning *Cl. perfringens*. More over Clostridium spores are able to persist the pasteurization of milk and cheese-making including ripening process, where they germinate into vegetative cells metabolizing lactate into organic acids, mostly butyric acid and gases such as CO_2 and H_2 with consequential abnormal aroma and cracks which defined as late blowing defect, a major cause of spoilage in semi hard and hard cheeses.

Microbial contamination and growth rate in many dairy foods can be reduced using one or more of the subsequent treatments: pH reduction by lactose fermentation into lactic acid, adding acids or other approved preservatives, restriction the growth of undesirable microorganisms using desirable microflora, sugar or salt addition to reduce the water activity (aw), packaging to limit available oxygen and freezing. A useful indicator for assessing the overall quality and safety of dairy products and monitoring the sanitary conditions applied during the production, collection and handling is the Standard Plate Count (ICMSF, 1978). Microbiological quality of dairy products and post heat treatment contamination can be also determined using coliform count, among these group E. *coli* which is considered the most common pathogen causing milk and dairy products borne outbreaks (Melkamsew *et al.*, 2012).

Conclusion

The microbes present within raw milk are complex. The dominant, and subdominant, microorganisms present in raw milk can have a variety of influences on the flavour, taste and texture of dairy products. A number of these microorganisms also have the potential to contribute to health through the production of antimicrobials or possessing other probiotic-associated traits. With the globalization in the dairy industry, change in milk production strategies is necessary to ensure quality milk production. Since the quality of raw milk has a direct impact on the quality of product prepared from it, quality of milk has to be control at the grass root level itself.

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PROBIOTIC STARTER CULTURES FOR VALUE ADDITION OF MILK

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Introduction

India has attained a sustained growth in milk production and availability of milk and milk products. Dairy activities open up a lot of avenues for employment and contribute significantly to the rural Indian economy. Value addition is about creating an extra value over and above its original value and this is quite integral in food value chain also. Value addition involves integrating a 'new process' or making a particular' enhancement' in the product so as to meet consumer demand which at the same time ensures better returns too. Improved milk availability and the change-over to market economy has made dairy sector quite alluring for private segments. Most entrepreneurs focus on value addition of milk to increase the variety of milk products and improve their availability. With changes in consumer concerns, and increase in disposable income, present day consumers prefer foods that provide some extra health benefits rather than simple nutrition. Market studies indicate that consumers are searching for healthier alternatives and this has become still more relevant in this pandemic era. Such foods must also fit into current lifestyles providing convenience and also an acceptable price-value ratio.

Probiotic bacteria are becoming increasingly popular as a result of the continuously expanding scientific evidence of their health benefits. The association of probiotics with human well-being has a long history. Though unknown of its health benefits, probiotics in the form of fermented milk products have been in regular and continuous use as a source of nutrition by our ancestors. Kefir, Koumiss, Leben, Arka, Matzun, Yoghurt are some popular nomadic beverages that have been in use in different parts of the world since centuries. Etymologically the term probiotic is derived from the Greek language meaning "for life". This definition of has evolved over time. Probiotics are live microbial feed supplements which beneficially affect the host animal by improving microbial balance". WHO have now redefined probiotics as "live microorganisms which when administered in adequate amounts confer a health benefit on the host.A growing awareness on the relationship between diet and health has led to an escalating demand for fermented milk products that provide health benefits in addition to basic nutrition. Thus, there is enough scope for using 'fermentation'for value addition of milk.

Probiotics - History

Elie Metchnikoff (1894-1916) a Russian Doctor observed the importance *Lactobacillus bulgaricus*, in delaying ageing and providing beneficial effects in the human digestive tract. The concept, presented through the book entitled 'Prolongation of life', is the starting point for the still continuing researches on probiotics. Elie Metchnikoff was acknowledged for his contributions in this field by conferring the title "Grandfather of Probiotics". In tune with these observations, several researches happened in Europe also. Alfred Nissle isolated a strain of *Escherichia coli* from the stool of a soldier who unlike his comrades survived an attack from *Shigella dysenteriae*. The strain now designated as *E. coli Nissle*, a non lactose fermenter is still being used as a probiotic. However, the ultimate breakthrough happened in Japan, when Minoru Shirota a medical student of Kyoto University established the positive influence of *Lactobacillus caseistrain Shirota* in the gut. The success of Yakult (drink prepared using *Shirota* strain) as the most popular probiotic drink in the International scenario prompted the industry giants Nestle, Danisco, DSM, Chr-Hansen, Unilever and Yakult to invest in this field. In India, researches in this direction to identify the most appropriate strain for Indian population is progressing with the support of Indian Council of Medical Research (ICMR), National Dairy Research Institute (NDRI) and Department of Biotechnology, Government of India (DBT).

Probiotics – Mechanism of action

The digestive tract of adult human contains trillions of microorganisms belonging to more than 1000 different species that includes both desirable and undesirable flora. In a healthy individual there is a perfect balance between desirable and undesirable flora. Under stress, the balance of this nurturing ecosystem will be lost and often this results in gastrointestinal disturbances. Probiotics together with other beneficial bacteria in the GI tract out compete pathogens for nutrients. They also produce antimicrobial substances as metabolic end products. The interaction of probiotics with the immune system and gut brain axis is reported to alleviate autism related behavioural abnormalities. Consumption of at least 10^9 to 10^{10} probiotic cells per day is said to impart beneficial effects.

Probiotics are living microorganisms that confer health benefits to the host when administered in adequate amounts; however, nonviable cell and their components can also exhibit beneficial properties. Probiotics prevent and ameliorate the course of digestive disorders such as acute, nosocomial, and antibiotic-associated diarrhea; Clostridium difficile-associated diarrhea and some inflammatory bowel disorders in adults. They are also found to be effective in combating allergic disorders such as atopic dermatitis (eczema) and allergic rhinitis in infants. In addition, probiotics may be of interest as co-adjuvants in the treatment of metabolic disorders, including obesity, metabolic syndrome, nonalcoholic fatty liver disease, and type 2 diabetes. The mechanisms of action of probiotics are diverse, heterogeneous, and very strain specific. Commonly purported mechanisms include, colonization and normalization of perturbed intestinal microbial communities, competitive exclusion of pathogens, bacteriocin production, modulation of fecal enzymatic activities, inactivation of carcinogens and xenobiotics, production of short-chain and branched-chain fatty acids that modulate tissue insulin sensitivity, cell adhesion and mucin production. Modulation of the immune system which results mainly in the differentiation of T-regulatory cells and up regulation of anti-inflammatory cytokines and growth factors; interleukin-10 and transforming growth factor, interaction with the brain-gut axis. Anti-cancerous effect is by enhancing host immune response, binding and degrading antigens, and reducing nitrosamine formation from nitrates in food material (Diaz et al, (2019).

Some terms used in connection with probiotics:

Prebiotics: The ‘prebiotic’ concept was introduced for the first time in 1995 by Glenn Gibson and Marcel Roberfroid. Prebiotic was described as “a non-digestible food ingredient that beneficially affects the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon, and thus improves host health”. In 2008, the 6th Meeting of the International Scientific Association of Probiotics and Prebiotics (ISAPP) defined “dietary prebiotics” as “a selectively fermented ingredient that results in specific changes in the composition and/or activity of the gastrointestinal microbiota, thus conferring benefit(s) upon host health”. Galacto-Oligosaccharides (GOS), Fructo-Oligosaccharides

(FOS), starch and glucose derived oligosaccharides, pectins and non-carbohydrate oligosaccharides such as flavanols are considered as prebiotics

Synbiotics: A synbiotic is defined as a "mixture of probiotics and prebiotics that beneficially affects the host by improving the survival and activity of beneficial microorganisms in the gut." Synbiotics are those products in which the prebiotic compound selectively favors the growth of probiotics and their metabolite production.

Postbiotics: The newest member of the biotics family. It refers to bioactive compounds produced by food-grade microorganisms during a fermentation process. Postbiotics include microbial cells, cell constituents and metabolites. These are otherwise called as Paraprobiotics or parabiotics.

Psychobiotics: Psychobiotics refer to live bacteria or probiotics that, when ingested in appropriate amounts, might confer a mental health benefit by affecting microbiota of the host.

<u>Alphabets of probiotic action</u>

A - Antagonism by production of bacteriocins (Antibiotic associated diarrhoea)

B - Bioconversion of sugars to end products with inhibitory properties

C - Competition for growth substrates

D - Displacement of pathogens

E - Exclusion: Competitive exclusion for binding sites

F - Formation of tight junctions

G - Growth substrate formation eg. EPS, Vitamins

H - Halting inflammation

I - Innate immune response stimulation (Irritable bowl syndrome)

Table 2. Microbial strains as Probiotics (FSSAI Schedule VII)

Sl. No.	Genus	Species
1.	*Lactobacillus*	*Lb. acidophilus* *Lb. rhamnosus* *Lb. reuteri* *Lb. casei* *Lb. gasseri* *Lb. plantarum* *Lb. salivarius* *Lb. brevis* *Lb. johnsonii* *Lb. delbreuckiisspbulgaricus* *Lb. fermentum* *Lb. caucasicus* *Lb. paracasei*

		Lb. delbruckii *Lb. gallinarum* *Lb. amylovorus* *Lb. lactis* *Lb. helveticus*
2.	*Bifidobacterium*	*B. bifidum* *B. lactis* *B. brve* *B. longum* *B. animalis* *B. infantis*
3	*Bacillus*	*Bacillus coagulans*
4	*Streptococcus*	*Str. thermophilus*
5	Saccharomyces	*S. boulardii* *S. cervesiae*

Probiotic foods – Most commercialized functional food

Functional foods deliver additional or enhanced benefits over and above their inherent nutritional value. Current consumers prefer foods that are "naturally functional". This pandemic era has witnessed the launch of functional foods like HaldiDoodh and Golden Milk with added curcumin by our own co-operatives - Amul and Milma. Presently the probiotic market comprises of post-biotics, pharma-biotics, psychobiotics and medical probiotics. The marketing strategy is focusing highly on the "Gut-brain-Axis" and "Leaky gut" with a view to address life style diseases that are increasing at an alarming rate. Moreover research findings indicate that, in future malnutrition issues also could be dealt by 'engineering a healthy gut 'through modulation of gut microbiome. In India, functional food and beverages have emerged as the fastest growing market at a CAGR of 22-23%. The largest segment of this market comprises foods belonging to probiotic dairy foods, Yoghurt and its functional variants are growing at a rate of more than 14% on year to year sale. Probiotic variant of flavoured milk, smoothies, ice cream, infant milk formulae and cheeses are available in the market shelves. Nestle has recently launched an infant milk formula containing *Lb. reuteri*.

Value addition

Value addition of product and process technology has elevated the Indian Dairy Industry to new heights. Value addition is defined as the process of converting deficiency to sufficiency efficiently. (Agricultural Economics Research Review – 2011). This is acting as the key tool to support surplus in most efficient way. The millennial concept of value addition is mainly connected to new insights on customer preferences. Industry focus on convenient products with clean label and health benefits at reasonable costs with no compromise on quality.

The value of the product can be enhanced by incorporating probiotics. The business of probiotic food is skyrocketing with innovative consumer-oriented products. Major value additions are happening in yoghurt due to its wide acceptance and international presence. Probiotic variants of yoghurts account for 76% of total probiotic sale all over the globe. The acquisition of popular fermented drink maker Kevita by Pepsi Co, clearly shows the market trend.

Table 3. Values addition of fermented probiotic dairy products – An economic analysis

Product	Milk	Set curd	Yoghurt	Flavoured yoghurt/ Shrikhand	Probiotic yoghurt	Probiotic frozen yoghurt/ Probiotic lassi
*Price/100 ml	5.00	8.00	12.00	15.00	20.00	30.00
Appreciation	--	60%	140%	200%	300%	500%

*Average market price

Here one can easily visualise that extent of value addition that could be attained just by changing the type of starter culture. It is noteworthy that without any extra inputs in the infrastructure, it is possible to get an appreciation of 300% by using probiotic culture in contrast to 140% as in the case of yoghurt when ordinary starters are used. Hence the type of starter culture used is critical in deciding the cost of the product. There are so many agencies that are commercially manufacturing /distributing probiotic cultures in the DVS format for industrial use. Direct Vat Set starters (DVS) are highly concentrated standardised frozen or freeze dried form of defined single strains mixed to convenient blends for direct inoculation for product preparation. The demand and market for DVS culture is increasing annually at the rate of six per cent and Ninety eight percent of this demand is for probiotic cultures.

Table 4. Suppliers/Manufacturers of Probiotic DVS cultures

Sl. No	Name of Organisation /Trader	Address
01	Chr- Hansen : M/s Indras Agencies (Kerala)	No.38/587, KeshBharg, Monastery Road, Ernakulam Kerala. Email: salescochin@indrasagencies.com Contact: 0484 – 2365851,2365852,2365853, 9895471781
	Pan India	Chr-Hansen India Pvt Ltd, B-605, Everest Grand, Mahakali Caves Road, Opp. Ahura Centre, Near MIDC, Andheri, Mumbai. Email: INCCS@chr-hansen.com Contact: 022 61399200
02	DSM Delvo:	No.66/3800, Galaxy Square, Rajaji Road, M G Road, Ernakulam, Kerala Email: minhaj@pepperosalt.com, Contact: 9731920122
	Pan India	DKSH India Pvt.Ltd., Fantree Building, Plot No.369, Sarla Software Park, MarolMaroshi Road, Opposite Seven Hills Hospital, Andheri East, 400 059 Mumbai, India. Contact: 9886533895
03	AB Source Biological	ABsource Biologics Pvt. Ltd., Kinetic Innovation Park, D-1 Block, Plot No. 18/1 Part, MIDC, Chinchwad Pune - 411019. Email: info@absourcebiologics.com Contact : 9168696640 / 9028311133

At present leading manufactures like Amul, Nestle, Unilіver, Arla, Chobani. rely solely on imported cultures for production manufacture of fermented milk products. In India, the search for a suitable probiotic strain is continuing.

COVID-19 and Probiotic Business

Even before Covid-19 pandemic, consumers were following a holistic approach towards wellness. The pandemic has changed the way consumers shop, eat, socialise and entertain. This has transformed our food culture. More importance is being given to functional foods to stay healthy. Family packets have changed to Ready to eat individual packet as social distancing is 'ON'. Taste' has become a back seater while immunity boosting has come to the forefront. The market for protein rich foods like cheese, paneer and fermented foods especially probiotic is escalating. The demand for yoghurt and paneer increased by more than 40% during this period, over ice cream and butter. Together with this the business of prebiotic is also on a rise. Abbott has introduced 'Pedialyte', a rehydration product with immune support containing more zinc and vit C for better digestive health. Globally the market is growing at a CAGR of 9%. Data show, 20% of total online business is dedicated to the functional products in this covid scenario. Latest data from Euromonitor International (2021) shows the global probiotic market is worth 50 million Euro, and yoghurt continues to be the leader. Probiotic supplement segment is also growing. Business of other fermented milk product is growing at 14% and similar trend is evident in India.

Conclusion

Health awareness among consumers is on the rise, and most consumers are constantly in search of healthy food products for daily consumption. The increasing evidence of health benefits and health restoration potential of probiotics is increasing the customer expectations from probiotics. Small scale entrepreneurs too can tap the market potential of probiotic products, provided they have the technical know - how of the starter culture. Microbes residing in our body decide our 'wellnes's. Researches are ongoing to transform the non-conventional dairy products to the status of 'probiotics' Academia industry, and regulatory bodies should work hand in hand to overcome innovation barriers.

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RECENT DEVELOPMENTS IN THE TRADITIONAL DAIRY PRODUCT SECTOR

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Traditional dairy products are an integral part of Indian heritage. These products have great social, cultural and economical importance and have been developed over a long period with the culinary skills of homemakers and Halwais. Manufactures of traditional dairy products add value to milk and also provide considerable employment opportunity. Traditional dairy products not only have established market in India but also great export potential because of strong presence of Indian Diaspora in many parts of the world.

Traditional/ Indian dairy products can be defined as all milk products which are originated in India and which were evolved over ages utilizing locally available facilities. A wide range of Indian milk sweets made in different parts of the country are very popular amongst consumers throughout the world. Traditional dairy product sector offers vast scope for innovation, value addition and product diversification. Currently Indian milk products sector is the largest and fastest growing segment of the dairy industry. Since olden time variety of traditional and value added dairy products have been manufactured by converting the surplus milk during the peak season of milk production as a means of preservation. The traditional dairy sector in India is undergoing radical changes to cope up with changing demands of today's consumers. Major trend is the reduction in calorie content of these products by partial or complete replacement of sugar and or fat. Calorie cutting is done by the use of intense sweeteners and fat replacers to the extent that would not harm the product's natural appeal.

Fat is most expensive among major food constituents and it acts as carrier for other fat soluble constituents; improves body, texture and mouth feel and imparts rich flavor to the product. But it provides maximum energy so it is often unwanted and is replaced from the foods. Fat replacers are compounds that functionally and/or chemically resemble fat but provide very less energy. Fat replacers are divided in to 2 main groups viz., fat substitutes like olestra, salatrim, caprenin, sorbestrin and fat mimetics, which are either proteins or carbohydrates that can mimic the properties and functions of fats in foods

Fat replacers have been developed to reduce the quantity of fat in foods and help people lower their fat intake. Some fat replacers are used as fat substitutes to replace fat in a food, whereas others are used as fat 'mimetics' to impart the sensory qualities of fat and partially replace fat. There is no single ideal fat replacer that can recreate all the functional and sensory attributes of fat. Instead, several ingredients are used in combination to achieve the required characteristics for a particular application.

Fat replacers are grouped into three categories based on their source as carbohydrate based, protein based and fat based fat replacers. Both digestible and non-digestible carbohydrates have been used to partially or totally replace the fat as they exhibit desirable properties like water binding which improves rheological characteristics, viz., body, texture, viscosity and consistency. Protein based fat replacers are derived from proteins of animal or plant origin. These are microencapsulated to form microscopic coagulated round deformable particle that mimic the mouth feel and texture. Some of them are processed to modify other aspects of ingredient functionality such as water binding. Protein based fat replacers are designated as GRAS by USFDA. Fat based fat replacers or synthetic fat replacers are triglycerides with tailored configuration to reduce calorie content.

Carbohydrate – based fat replacers

Starch – derived fat mimetics

Carbohydrate – based fat replacers are derived from cereals, grains and plants, these ingredients include both digestible and indigestible complex carbohydrate.

Maltodextrins are defined by FDA as non- sweet, nutritive saccharide polymers consisting of D-glucose units linked primarily by α-1-4 bonds with a dextrose equivalent (DE) of less than 20. The low DE maltodextrins at a DE range of 1 to 10 has been found particularly useful in fat replacement.

Modified starches

The main functions of modified starches are as bodying agents and texture modifiers intended to be used with emulsifiers, proteins, gums and other modified food starches. The main commercial modified starches are Oatrim and Z-trim (Owusuapenten, 2005). Oatrim is known also as α-Trim TM, Trim choice. Oatrim produces 1-4 kcal/g. These types of fat mimetics are made by partial enzymatic hydolysis of oat starch. The water soluble products of oat flour are used to replace fat and as a texturizing ingredient. Oatrim is classed as GRAS (generally regarded as safe) by the FDA. This ingredient may be used for baked goods, frozen desserts, dairy beverages, cheese and confections (Owusu-apenten, 2005). Z-trim is an insoluble fiber from oat, soybean, pea and rice hulls or from corn or wheat bran. The mouth feel of Z-trim is similar to fat in terms of its moistness, density and smoothness. Z-trim has the further advantages of increasing the fiber content of food. It has FDA status and can be used with baked products, cheese, ice-cream and yoghurt.

Protein-Based Fat Replacers

Protein-based fat replacers are typically made from milk and whey proteins modified by a process called microparticulation. As the name implies, this process produces tiny particles. In the mouth, the particles act like tiny ball bearings, rolling over one another easily. The end result is a food with the same creamy, slippery texture of its higher-fat counterparts. Protein-based fat replacers are commonly used in butter, cheese, mayonnaise, salad dressings, frozen dairy desserts, sour cream, and baked goods. These fat substitutes generally give a better mouthfeel than do carbohydrate- based substances.

Micro-particulated protein is made from micro-particulated milk and/ or egg-white proteins, sugar, pectin, and citric acid. When added to foods, these products successfully perform many of the functions of fat, and they impart a fatlike creaminess and richness. As micro-particulated protein fat replacers are not heat-stable, they are used chiefly in cold products such as ice cream, butter, margarine, sour cream, and salad dressings. Micro-particulated protein fat replacers provide 1.33 calories per gram, as compared with the nine calories per gram of regular fats.

Modified whey protein is made from high quality whey (or milk) protein concentrate. Modified whey protein does an excellent job of improving the texture, flavor, and stability of low-fat foods. It replaces fat at four calories per gram and is typically used in frozen dairy desserts; in hard and processed cheeses; in sour cream, dips, and yogurts. Its ability to prevent shrinkage and iciness in frozen foods makes it especially desirable as a fat replacer in those products.

Fat-Based Fat Replacers

Fat-based fat replacers are the newest category of fat replacers. They have most acceptable taste of any of the fat substitutes and they provide a mouth feel closest to that of fat. Fat-based fat replacers are made from some of the same ingredients found in natural fats. But because these ingredients are formulated in such a way that the body cannot absorb them completely—in some cases, not at all—they contribute either fewer calories than their ordinary counter parts or no calories.

Sucrose Polyester, also known as olestra is the first calorie-free fat substitute approved by the U.S. Food and Drug Administration. Most dietary fats are triglycerides: As the name indicates, they are composed of a carbohydrate (glycerol) with three fatty acids attached. Instead of having a glycerol at its core, olestra contains a larger sugar molecule (sucrose) and has six to eight instead of the usual three fatty acids. Olestra looks, tastes, and acts like real fat, but its formulation causes it to pass through the body totally unabsorbed, contributing no calories to the diet.

Fiber based fat mimetics

Microcrystalline cellulose is colloidal products based on co-processing microcrystalline cellulose with sodium carboxy methyl cellulose. A recent addition to the colloidal microcrystalline cellulose products was based on co-processing with alginates or whey or maltodextrin. These products are readily dispersed and are now used as fat replacers in numerous food products. The food products where microcrystalline cellulose are most frequently used as fat replacers include salad dressings, bakery products, dairy products, ice-cream and frozen desserts, cheese spreads and processed meats. The standard usage levels range from 0.4 to 3.0%.

Sugar replacement by using Non-nutritive sweeteners.

Sugar overconsumption continues to increase worldwide and contributes to multiple health-related issues. Consumer demands for healthier products are leading to a large push for sugar reduction in dairy foods. Sugar plays an important role in dairy foods, not only in flavor but also in texture, color, and viscosity. Replacing sugar can have negative effects, making substitution inherently difficult. Natural and artificial nonnutritive sweeteners exist for sugar reduction.

Bulk sweeteners confer body & texture to foods and provide energy, so they are also referred to as nutritive or calorie sweeteners. Intense sweeteners are hundreds of times sweeter than sucrose (George, 2007), they impart the sweetness but contributes almost nothing in the calorie content. As these are generally not metabolized by body and are excreted unchanged, they are also called as non-nutritive sweeteners. For this reason, non-nutritive sweeteners are being used wherever needed and permitted. According to Calorie Control Council (2004), an ideal non-nutritive (artificial) sweetener should have the same sweetness as sucrose, should be odourless, colourless, stable and readily soluble in food system. It should be functional, economically feasible, non-carcinogenic and non toxic. Now, they are being tried in almost all the sweet products to replace sugar as sweetener. In some products such replacement is successful, while in some it is not because of flavor and stability related problems.

Term	Characteristics
Nutritive	Provides energy in the form of carbohydrates while additionally contributing calories (FDA, 2015a)
Non-nutritive	Very low in calories (0.08 cal/g) or contain no calories at all; often sweeter than sugar on a weight by weight basis
High-intensity	Many times sweeter than sugar on a weight by weight basis but contribute only a few to no calories when added to food
Artificial/synthetic	Synthetic sugar substitutes such as sucralose or aspartame that are noncaloric sweeteners

Milk based sweets are extremely popular in India and several efforts are being made to produce the sweets using Non-nutritive sweeteners in place of sugar. Some of these sweeteners such as aspartame, saccharine, acesulfame and sucralose have been used to replace sugar so as to reduce the calorie content of product (Gawande, 2006). By virtue of its sweetness, non nutritive sweetener can completely replace sugar but it alone cannot provide bulk and other functional characteristics of sugar, so it is often used with one or more bulking agents, which impart the required functional characteristics.

Sorbitol

It has been used in processed foods for half of century as sweetener, humectants and texturizing agent. It is a natural sugar alcohol present in many fruits especially in cherry and pear. Industrially, it is obtained by hydrogenation of glucose derived from starch and invert sugar. Sorbitol has got a smooth mouth feel, and is 0.6 times as sweet as sucrose. It is very stable and chemically unreactive, and can withstand high temperatures and does not participate in Maillard reaction. It combines well with other food ingredients, including sugar, protein, fats and functions well in chewing gums, frozen desserts, icings and filling

Aspartame

Aspartame is made of the two amino acids aspartic acid and phenyl alanine. It is about 200 times sweeter than table sugar and was approved as a table top sweetener and in products such as chewing gums, cold breakfast cereals and dry bases foods (i.e., beverages, instant coffee and tea, gelatine, puddings, fillings, and dairy products and toppings). Aspartame is one of the most exhaustively studied substances in the human food supply, with several studies supporting its safety. In 1983, US FDA approved the use of aspartame in carbonated beverages and in 1996, for use as a "general purpose sweetener". Labels of aspartame-containing foods and beverages must include a statement informing individuals with a rare hereditary disease known as phenyl ketonuria that the product contains phenylalanine, as they have difficulties in metabolizing it.

Sucralose

Sucralose is a non-caloric sweetener about 600 times sweeter than sugar, and was approved by the US FDA for use in 15 food categories in 1998 and for use as a general-purpose sweetener for foods in 1999. It is a general-purpose sweetener that can be found in a variety of foods including baked goods, beverages, chewing gum, gelatine and frozen dairy desserts. It is also heat stable like Ace-K. Sucralose has been extensively studied and several safety studies in humans are available. US FDA reviewed several safety trials before approving the use of sucralose as a general-purpose sweetener for food.

Neotame

Neotame is approximately 7,000 to 13,000 times sweeter than table sugar. US FDA approved neotame in 2002 for use as a general-purpose sweetener and flavour enhancer in foods (except in meat and poultry). It is heat stable, and has proven safety; US FDA had reviewed data from animal and human studies designed to identify possible toxic effects, including effects on the immune system, reproductive system, and nervous system. Similarly, after considering all the data on stability, degradation products and toxicology, the EFSA panel concluded that neotame is not of safety concern with respect to the proposed uses as a sweetener and flavour enhancer.

Steviol glycosides

Steviol glycosides are natural constituents of the leaves of Stevia Rebaudiana Bertoni, a plant native to parts of South America and commonly known as Stevia. There are three types of products available from Stevia i.e. high purity steviol glycosides, stevia leaf and its crude extracts. Only high purity steviol glycosides are approved by the US FDA. They are reported to be 200 to 400 times sweeter than table sugar. High purity steviol glycosides are GRAS, and as such do not require US FDA approval as a food additive. Based on its review of information and data submitted by industry in GRAS notices, has granted the GRAS status to certain high-purity steviol glycosides for use in food [24]. Similarly, high-purity steviol glycosides are also approved as safe for human consumption by the EFSA. However, stevia leaf or its crude stevia extracts are not considered GRAS and do not have FDA approval for use in food.

Artificial sweeteners permitted in sweets by FSSAI.

Name of sweetener	Article of food	Maximum limit (ppm)
Aspartame	Halwa, Mysore pak, Boondiladoo, Jalebi, Khoyaburfi, Peda, Gulabjamun, Rasagolla and similar milk product-based sweets sold by any name	200
Sucralose		750
Saccharin Sodium		500
Aceslfame K		500

Conclusion

Traditional dairy product sector offers vast scope for innovation, value addition and product diversification. The changing life- styles and increased health problems especially among urban population has necessitated the research efforts for formulating low calorie traditional milk products with added convenience and enhanced health benefits. Manufacture of Indigenous dairy products with low calories will provide a successful outlet for traditional milk products.

RECENT ADVANCES IN PACKAGING OF DAIRY PRODUCTS

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Introduction

In a country like India, milk and dairy products are an integral part of our diet. There is hardly any other natural food that provides us with the nutrients that our body needs better than milk. Approximately 46 percent of all milk produced in our country is consumed in liquid form and 47 percent is converted into traditional products such as white butter, ghee, paneer, khoa, curd, malai, etc., and only 7 percent of milk is used in the manufacture of Western products such as powdered milk, processed butter, and processed cheese. Among the dairy products produced by the organized sector, some of the most famous are ghee, butter, cheese, ice cream, powdered milk, malted milk foods, condensed milk, baby food, etc.

Presently only 12% of the marketed milk is represented by packaged and branded pasteurised milk. The appropriate packaging of dairy products is of utmost importance not only to preserve nutritive value and saving of wastage, but also to improve the marketability to achieve better returns. Milk in its various forms gives ample challenging opportunities to the packaging manufactures from the field of glass, metal, paper, plastics etc. to innovate and introduce packaging solutions which can be easily adopted in our country. The challenge to the packaging fraternity is to deliver the nutritious dairy products to the consumer in most economical, hygienic, safe and environmentally friendly packages.

Packaging plays a vital role in keeping the quality of milk as well as marketing of the products. Packaging is called the 5th "P" of the Marketing Management, followed by Product, Price, Place and Promotion. After shifting the marketing channel form the Grocery shop concept to the Mall Concept packaging plays a major role in selling the product. Therefore, the packaging is also called "silent seller". Packaging can be described as a coordinated system of art, science, technology and commerce that guarantees the safe delivery of products to the end user in perfect condition at a minimum total cost. With perishable products such as milk and its products, packaging is very important for the safe delivery of the product to the consumer without altering its properties and nutritional value. Milk and dairy products spoil rapidly at temperatures above refrigeration and in the presence of oxygen and other contaminants in the atmosphere.

Basic role of dairy packaging, as well as for any other food product, is to provide a physical barrier to food in order to prevent the item from different damage including mechanical, physical, microbial contamination, etc. and to maintain the best product quality. In the ideal case the packaging should constrain weight and nutrient losses as well as help in extending shelf life of packed item.

A package must have four preliminary functions.

(1) Containment: - It contains the food product for ease and safety during transport. Also it protect the product against spillage, evaporation or pilferage losses.
(2) Protection: - Protect the product against contamination from microorganism through dust, dirt or vermin. It also protect against degradation from exposure to environmental factors such as light, dirt, moisture and oxygen.
(3) Convenience: - It provides convenient means of dispensing the product in desired quantities- bulk or retail.
(4) Communication: - It should communicate to the consumer about the nature of material packed, type of storage, method of use etc.

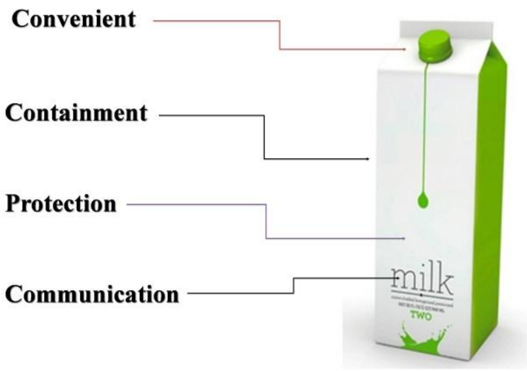

Fig 1. Important functions of a package

Food packaging today is not only about product friendliness and proper protection, it is also involved in many other applications, such as informing the consumer about the content and highlighting important information about the packaged product. Historically, liquid milk packaging began around the 19th century with the invention of condensed milk production and was related to the use of glass bottles. The first plastic-coated milk carton was used in 1932. Over time and with the development of the food industry, new packaging methods have also been introduced. Modern milk and dairy products are packaged in different materials taking into account many factors, such as product type, processing and storage conditions, handling requirements, and end use. The most widely used are glass and / or plastic bottles, laminates (multilayer materials), bags, plastic cups, cans and other containers. They all have one thing in common: they must be printable and contain all the product information required by law. Although the packaging material is generally required to be inert and not interact with the packaged dairy product, current trends focus on the development of packages that incorporate certain interactions to extend shelf life. So-called active, smart or smart packaging concepts guarantee this.

Packaging materials convenient for dairy products

When choosing packaging material for dairy products, various important factors need to be considered such as toxicity, compatibility with the product, impact resistance, maintenance of sanitation, odour and light protection, chemically inactivity, shape and weight requirements, marketing appeal, printability and cost. The nature and the characteristics of the dairy product to be packaged define the selection of the appropriate packaging material and method. For example, if the product is susceptible to oxidation (such as butter) a selected material needs to have high barrier properties toward oxygen in order to enable the declared shelf life. Similarly, if the dairy product needs to be thermally treated after it has been packaged; the chosen material has to be heat tolerant.

Conventional packaging material used for dairy products

Pasteurised Milk:

In our country, a large quantity of milk was earlier sold in an unprocessed, unpacked condition. Milk was brought by the vendors in aluminium containers to the doorsteps of the consumers. In the packed form, milk was sold in returnable glass bottles sealed with aluminium foil cap. Clear glass bottles of 500ml capacity conforming to IS: 1392– 1967 (specification for glass bottles for milk) were used in the early stage. The glass bottles offered certain advantages like transparency, rigidity, hygienic and non-toxic nature and compatibility. However, due to the inherent nature of glass, certain problems such as high tare weight and fragility emerged.

Table 1. Characteristics of various packaging materials used in dairy industry

Material	Trans-mission of water vapour (g/m^2/day) at 38°C 90% RH	Gas permeability (cm^3 $mm^2 Pa^{-1}$ / day at 25°C 50% RH			Advantages	Disadvantages	Products
		O_2	N_2	CO_2			
Glass	low	low	low	low	Impermeable, easily recycled, inert	Heavy weight, breakable, high energy costs of manufacturing	Fresh milk, yogurt, cream
Metal	low	low	low	low	Excellent gas barrier, rigid, easily recycled	Requires coatings to prevent corrosion	Milk powder, Condensed and Evaporated milk
Films							
Polyvinylidene chloride, PVDC	3.1	$2.28x10^{-10}$	$2.28x10^{-10}$	$1.9x10^{-10}$	Excellent barrier to water vapour, gases, fatty and oily products	Produces toxic compounds when incinerated	Chesses, MAP
Cellophane, nitrocellulose coated	4.7	$1.76x10^{-11}$	$1.76x10^{-11}$	$1.7x\ 10^{-11}$	Excellent clarity and sparkle, can be used in coatings and laminations	Not strong for heavy products	cheeses
Plastic							
Low-density Polyethylene, PE-LD	20.2	$7.17x10^{-9}$	$7.17x10^{-9}$	$2.85x10^{-9}$	Very flexible, highly resistant to most solvents, good moisture barrier	Useless for rigid containers, poor barrier for gases	Liquid milk (pillow packs), condensed milk (squeeze bottles)

High-density Polyethylene, -HDPE	4.7	$1.79x10^{-9}$	1.79x10-9	$8.15x10^{-9}$	Moderately flexible, stiffer, tasteless, odourless	Poor barrier for oxygen and other gases, softness, low softening point, poor clarity	Milk, yogurt, sour cream, ice cream
Polyvinyl chloride (PVC)	62	$2.44x10^{-9}$	$2.44x10^{-9}$		Versatile material, compounded with a wide range of additives (plasticized	Difficult to recycle, poor moisture barrier properties	Cheese, yogurt, MAP
Polyethylene Terephthalate, PET	Low	Low	low	low	High tensile strength, low gas and moisture permeability, high use-temperature range, high scuff resistance, excellent oil barrier	Lack of heat sealability	Milk
Paper							
Laminated papers	Low	Low	Low	low	Laminated to aluminium foil and extrusion coated with PE offers barrier to moisture, flavour, and UV light	Poor barrier for gases	Butter
Co-extruded laminated (aseptic)	Low	Low	Low	Low	Barrier against moisture, gas, odour, light, and UV light	cost	Milk, milk powder, yogurt
Waxed papers	High	low	low	Low	Moisture barrier, low cost, good resistance, good heatsealing characteristics	Difficult to keep folded	Tubs for ice cream or cream, butter

Today, many plastic (HDPE) bottles are also used to pack milk. Plastic bags replace glass bottles. Plastic bags are usually made of low-density polyethylene (LDPE film). Coextruded LDPE-LLDPE film is also used for its advantage in eliminating hole problems and achieving high puncture resistance. The films are 6570 m thick. The bags are formed and filled on Form fill seal (FFS) machines in 500 ml and 1000 ml capacities. The film must match is: 11805-1999 milk film.

Aseptic packaging, commonly known as Tetrapak milk. This system offers a long shelf life of approximately 3 to 6 months with no refrigeration or the addition of preservatives. A Tetrapak box is made of a composite material comprising 5 to 6 layers, including cardboard, aluminium foil, and polyethylene. In the distribution system, the pouches are placed in reusable multi-trip plastic crates. The crates are made of HDPE or PP and are nestable and stackable. The plastic crates conform to specifications laid down in IS: 11584 – 1986 crate for milk pouches.

Flavoured Milk:

The plastic-based material used for sachets is of Metallocene LLDPE (m-LLDPE). M-LLDPE when blended with 50% LDPE provides excellent puncture resistance, excellent seal strength and hot tack. Co-extended multiple levels low density films with an outer opaque film and an inner black film for reducing the transmission of light are also used.

In India, flavoured milk drinks are available in sterilisable crown cork glass bottles, glass bottles with aluminium foil lid or snap-on plastic lid, plastic sachets / Plastic bottles and aseptic packs (Tetra bricks).

Poly carbonate bottles with the leak proof screw cap are also used in place of glass bottles as these are unbreakable and are much lower (1/6th the weight of glass bottle). PET containers are in use as they are light, have good sales appeal and are strong.

Condensed and Evaporated Milk:

Traditionally, condensed milk was bulk packed in barrels or tinplate containers. In India, sweetened condensed milk is the most popular out of all other concentrated milks and is packed in conventional food cans with double seam ends. Evaporated milk is recently packed in aseptic tetrapaks.

Butter

The most commonly used butter wrap is the vegetable parchment paper of 45 gsm. Although parchment paper is grease proof, it does not provide a sufficient barrier to oxygen. For superior product protection and for longer shelf-life, aluminium foil laminated to parchment or greaseproof paper is used for which specifications are given in IS: 7161-1973 Specification for Vegetable Parchment or Greaseproof Paper/Al foil Laminate for Wrapping Butter. To avoid corrosion of aluminium foil (due to salt and lower pH of butter), it is coated with lacquer and a protective adhesive between the foil and paper is applied. The wrapped butter is placed in a plastic laminated paper-board carton to ease handling, distribution and storage at retail outlets under refrigeration. Recently, embossed aluminium foil backed parchment paper has been introduced for UV light protection and sales appeal. A popular packaging style in some countries is to use plastic cups and plastic tubs with lids in different shapes and sizes. For such applications, PP (Polypropylene) and ABS (Acrylo-Butadiene-Styrene) are widely used.

When butter is to be stored for a very long time and transported over long distances, hermetically sealed tinplate containers are used. Recent development is the use of smooth walled light-weight aluminium containers, which are convenient, colourful and hygienic. The containers are provided with printed or un-printed plastic or heat sealable foil lids. Butter packed in the metal containers has a shelf-life of one year and above.

Ghee

A major portion of ghee was packed in lacquered or un-lacquered tinplate containers of capacities ranging from 250 grams to 15 kilograms. Ghee packed in tinplate containers is fairly stable and has a shelf-life of over one-year Alternate packages, which are plastic based, are now gradually replacing tins.

For shorter shelf-life, 200 grams, 500 grams and 1 kilogram capacity pouches made of 5 layered Co-extruded polyethylene film are marketed, which are economical. Ghee is also marketed in lined cartons with flexible laminated plastics as inner liner materials and in tetrapaks. In both these packs long shelf-life is achieved. Laminated pouches of metallised polyester based films are also used. For packaging of ghee laminates of polyester, Nylon-6 and use of high barrier materials such as EVOH and EVAL can also be explored, as these materials could provide a fairly long shelf-life

Milk Powder

Milk powder is bulk packed in 25-kilogram capacity multiwall paper sacks with plastic liner made of polyethylene. The two typical structures used are:

4 ply construction of	5 ply construction of
One outer ply of crepe paper, three inner plies natural kraft and one inserted liner of LDPE.	One outer ply of kraft, one inner plus of kraft plus PE , three inner plies of kraft and one inserted liner of LDPE

Alternatively, the polyethylene liner can be laminated directly to the inner wall of the paper sack. The retail packs of milk powder traditionally are 500 grams or 1kilogram capacity tinplate containers with aluminium foil tagger. The containers are flushed with nitrogen gas for extension of shelf-life.

Plastic (HDPE) bottles are also used for packing skimmed milk powder. Stand-up pouches of metallised polyester/LLDPE laminates and polyester/LLDPE laminates are used for skimmed milk powder. For whole milk powder, a typical structure for a plastic pouch is 12µ polyester/ 9µ Al foil/50µ PE, and when gas flushed. Latest development is the increasing use of pouches made from co-extruded film of LLDPE-Nylon-LLDPE with gas flushing and laminates of Polyester/Metallized Polyester/Co-Ex. LLDPE are commonly used.

Ice Cream

The packaging should be designed in such a way that the pack performs efficiently to contain the product at freezing temperatures. Conventional form of packages include paperboard cartons, paper cups and in some cases, even metal containers. Dry ice pieces are wrapped in paper and placed around the ice-cream packs inside an insulated container, which is generally a corrugated fibre board box.

The various types of packages for ice-cream include:

- Paper board carton which is poly coated Thermoformed / injection moulded plastic containers made from HIPS (high impact polystyrene),
- PP (Polypropylene) or HDPE (high density polyethylene).
- The materials used for the lids are LDPE (low density polyethylene) or PS (polystyrene). The lids are of snap on type.

- Laminates of BOPP (biaxially oriented polypropylene) or PET (polyethylene terephthalate) are used for candies.
- Surface printed pouched made of 30-40 Microns Pearlised BOPP are also used.

Cheese

In India, the traditional package of cheese is a hermetically sealed printed tin-plate container in 400 / 500 grams capacities. Of late, 500 grams size slabs of cheese are also packed under vacuum in high barrier flexible laminates.

Individual packed slabs are then placed in rectangular transparent injection moulded plastic containers with lid.

Adequate moisture and oxygen barrier properties and to retain the vacuum are:

- Co-extruded LLDPE - TIE - Nylon - TIE -LLDPE
- Co-extruded LLDPE - TIE - EVOH - TIE -LLDPE
- Co-extruded film based on PVDC as the core material
- Laminates of metallised polyester / co-extruded nylon based film

Cheese / cheese spread is also packed in rectangular or triangular chiplets of 25 grams. The wrapping material used is aluminium foil. 8 or 10 Microns of the packed chiplets are placed in an outer plastic or paperboard container. Cheese spreads may also be packed in plastic tubs or plastic laminated or co-extruded squeeze tubes.

Yoghurt

Yoghurt is the product obtained from milk by souring it with harmless lactic acid bacteria. In our country the popular variety of yoghurt is dahi or curd and Mishti Dahi. In developed countries, the market of this product is rapidly expanding by the introduction of a wide variety of flavours. The traditional pack so far was the earthenware pot with a loose cover of glassine or greaseproof paper. Recently, injection moulded polystyrene and Polypropylene cups have been introduced with aluminium foil based peelable lids. These cups are available in capacities of 200 grams and 400 grams and provide a shelf life of about 10 days under refrigeration. The plastic cups are light in weight, easy to handle and are hygienic.

In the overseas markets, Polystyrene or Polypropylene plastic cups with heat sealable Al foil based lids are most popularly seen on the supermarket shelves. The latest trend is to use two compartment packages, wherein crunchy nuts and dried fruits are housed in one, and yoghurt in the other. After removing the foil lid, the contents could be mixed before consuming.

Drinking yoghurt in available in 200 ml up to 1kilogram packs. Besides tetrapaks and gable top carton, recently plastic bottles have also emerged in the Western markets, for this product.

Traditional dairy products

Traditionally, Indian dairy products have been manufactured by individual sweet makers- halwais and small entrepreneurs.

Traditionally, indigenous products have been packed in leaves, paper cartons or paper-board boxes. These materials do not provide sufficient protection to the product from atmospheric contamination and manual handling.

Use of saran coated films, laminates of aluminium foil with various substrates, metallized films and combinations of various packaging materials need to be tested for suitability for these products.

For instance, products like, gulabjamun and rasogulla need protection from light, oxygen, ingress or egress of moisture and micro-organisms; lacquered tinplate can is the most protective material, but this is very expensive.

The pack is extruded and laminated with PP-Al foil material. The foil provides the water vapour barrier properties, smooth curved corners and suitable printing surface for multicolour designs. The ends are injection-moulded and lined with the same type of laminate as used for the body. The size and dimensions can be adopted to suit the distribution systems and consumer's needs. The material is heat resistant and suitable for food contact. Similarly, suitable applications of retort pouches, stand-up pouches, tetrapak cartons and bricks need to be explored in the Indian dairy industry.

Novel Trends in Dairy Products Packaging

1. Modified atmosphere packaging (MAP)

Even though in the past decades MAP was already often used for different food products like fruits or vegetables, meat, fish and bakery products, it is still classified as novel method in packaging of milk and dairy products.

MAP belongs to a group of flexible packaging methods and is generated by altering the initial gaseous environment in the immediate vicinity of the products, whereby no further control during the storage period is performed. Modification of internal atmosphere is achieved by combining three main gases, carbon dioxide (CO_2), nitrogen (N_2) and oxygen (O_2). It aims to slow down deteriorative reactions (chemical and biochemical) and to inhibit or slow down the growth of spoilage microorganisms. This approach allows packing dairy with none or less preservative and therefore it became a popular solution for minimally processed foods which are increasingly being required by the modern consumers. When considering MAP application, permeability to O_2, CO_2 and water vapour transmission rates for packaging films are among the most essential factors in determining the package atmosphere composition, which may influence the product's deterioration rate.

Oxygen, nitrogen and carbon dioxide gases are the main gases used in MAP technology. In addition to these gases, carbon monoxide, ozone, ethylene oxide, nitrous oxide, sulfur dioxide, helium, neon, argon, propylene oxide, ethanol, hydrogen, and chlorine are the gases that can be used in MAP technology. However, they are not preferred because they are costly and impair the sensory properties of the products.

During the storage of the product, O_2 is consumed and CO_2 is produced by food respiration. N_2 is an inert gas used to prevent shrinkage of packages due to CO_2 absorption. N_2 is a tasteless and a low solubility gas that is also insoluble in water and oil, which causes it not to be absorbed by foods. Although this gas alone does not have any antimicrobial effect, it indirectly inhibits the development of aerobic microorganisms when used instead of O_2 to delay the oxidative rancidity in oxygen sensitive products.

CO_2, one of the main gases used in MAP technology, is the only gas with a significant direct antimicrobial effect. CO_2 can easily be added and removed from dairy products with no deleterious effects, making it a unique natural antimicrobial and processing agent. Easy solubility of CO_2 in water and oil causes the inhibition of microbial growth and also affects the lag phase, maximum growth rate, and maximum population density of microorganisms. Although the mechanism of action of CO_2 application is not known exactly, this gas penetrates into microbial cell and decreases the pH of microorganisms which inhibits the growth of microorganisms. Using CO_2 also prevents the bad odour that may occur during storage and transportation of the product. CO_2 is also known to have a prevention effect on food respiration. The direct addition of CO_2 to dairy products coupled with increasing the barrier properties of the containers has been commercially successful and economically feasible with cottage cheese and other fluid products with a shelf life increase of 200-400 %.

2. Active packaging

Active packaging is a packaging type which has an extra function providing a protective barrier for foods against external factors according to European Union Guidance to the Commission Regulation (EUGCR). Active packaging is an innovative packaging technology that incorporates certain additives into packaging film or within packaging containers by which package, product, and environment interact to prolong shelf life or enhance safety or sensory properties as well as maintain the quality of the food product. The package used in this type of packaging absorbs the unwanted components from food and headspace surrounding the food or on the contrary it enables the release of components, preservatives and antioxidants which are intended to be supplied to food or the air surrounding the food.

Broad classification of active packaging techniques includes:

Absorbing system	Releasing system	Other system
➢ Oxygen scavengers ➢ Carbon dioxide absorbers ➢ Ethylene absorbers ➢ Humidity absorbers ➢ Off flavours absorbers ➢ Lactose remover ➢ Cholesterol remover	➢ Carbon dioxide emitters ➢ Ethanol emitters ➢ Antimicrobial releasers ➢ Antioxidant releasers	➢ Self heating cans and containers ➢ Seif cooling can sand containers

Oxygen scavengers

O_2 present in the packages of foods such as dairy products cannot be completely removed even with vacuum packaging and MAP technology, thus it causes an increase in microbial load, aroma losses, unwanted odour, colour changes, and nutrition losses in time. The amount of O_2 in the package can be reduced to 0.01% in active packaging systems which O_2 scavengers are used. O_2 scavengers such as iron powder, sulphites, ascorbic acid, enzymes, and photosensitive dyes are used to absorb O_2 in the pack after packaging. Another method used in this system is to absorb O_2 in the package by the use of sachets and pads placed inside the packaging material. It is possible to prevent rancidity, discoloration and especially mould growth in cheese during storage of milk and dairy products.

Classification of oxygen absorber:

- Activation mechanism - auto activated, water activated and UV activated
- Scavenger form - sachet, label and extrudable component
- Reaction speed - fast, medium and slow effect

Commercially available oxygen scavenger with trade name are Ageless, Fresilizer, Oxyguard, Zero$_2$, Vitalon, PureSeal, Bioka and Sanso-cut are available.

Carbon dioxide scavengers and emitters

The amount of CO_2 required in the packaging material varies entirely depending on the type of product in the package. In some products, the amount of CO_2 in the package is desired to decrease and in some others it is desired to increase. Therefore, in the active packaging technology, it is possible to use CO_2 scavenger or CO_2 emitting components depending on the purpose.

CO_2 occurs because of spoilage and respiration in some foods, and may cause reduced shelf life of the product, deformation of the package, or even explosion. Using CO_2 scavengers such as silica gel, calcium hydroxide, sodium hydroxide, potassium hydroxide, and calcium oxide is effective in such products.

Sometimes, it is aimed to increase the amount of CO_2 in the package because CO_2 has a direct inhibitory effect on many aerobic bacteria and fungi. The rate of this effect varies according to the type of microorganism. For example, while it is possible to inhibit *Pseudomonas* spp. in the presence of about 20% CO_2, only a small proportion of pathogens such as *Clostridium perfringens*, *C. botulinum*, and *Listeria monocytogenes*are inhibited with the presence of less than 50% CO_2. It is possible to adjust the amount of CO_2 in the package to desired ratio, according to the type of microorganism which has a risk of occurrence in the product, by using various components in the packages. In such cases, it is aimed to spontaneously consume the O_2 in the package and to produce CO_2, after packaging. Iron carbonate and ascorbic acid or sodium bicarbonate mixtures are generally used for this purpose. In addition to the above-mentioned effects on microorganisms, O_2 scavengers or CO_2 emitters are also used in active packaging technology to increase volume in food packages and to preserve the appearance of bulk packages.

Moisture absorbers

As in many foods, high humidity is one of the most important causes of microbial spoilage in milk and dairy products. Since water activity is high in the presence of moisture, microbial growth accelerates in such environments. To increase the shelf life of the product by keeping the moisture content of the packages under control, various moisture scavengers are used in the active packaging technology.

Moisture absorbing pads and sheets are generally used in the active packaging of the products in which moisture content is desired to be kept under control. Active clay, silica gel, molecular sieves, calcium chloride and calcium oxide substances are commonly used components because of their moisture-absorbing properties.

Antimicrobial Emitters or releasing system

Antimicrobial packaging has gained increased attention especially in cheese packaging since it usually includes combination of an edible film or coating and an antimicrobial component. A conventional multilayer film exhibiting antimicrobial features usually includes four layers namely the control layer, matrix layer, barrier layer, and outer layer. In such structure, into the matrix layer, an antimicrobial substance would be imbedded. By the control layer adjacent to the matrix layer, aims to control the release of antimicrobial substance to the food surface.

Non edible antimicrobial films applied as active packages are classified into two groups –

a) antimicrobial containing films in which the antimicrobial agents migrate to the food surface
b) those with an antimicrobial agent, bounding to the film surface layer.

Complete or partial losing of antimicrobial activity of the applied active agent during film production and storage is one of the major drawbacks of antimicrobial films. Chemical preservatives that can be used in active antimicrobial- releasing systems include organic acids and their salts (primarily sorbates, benzoates, and propionates), parabens, sulphites, nitrites, chlorides, phosphates, epoxides, alcohols, ozone, hydrogen peroxide, diethyl pyrocarbonate, and bacteriocins. However, with aims to protect human's health and to produce chemical free foodstuff, their use is under the loop.

Antioxidant emitters

Lipid oxidation is one of the most important factors which shortens the shelf life of products such as milk and dairy products. The odour, aroma, and colour of the products change and also the nutritional value of food is lost with oxidation, because of the formation of toxic aldehydes and degradation of polyunsaturated fatty acids (PUFA). To prevent the changes in the product occurred by oxidation and to prolong the shelf life of the foods, the antioxidants are usually incorporated into the packaging materials and these antioxidants pass into the food or air space around the food during storage. Antioxidant compounds scavenge radicals by inhibiting initiation and breaking chain propagation or suppressing formation of free radicals by binding to the metal ions, reducing hydrogen peroxide and quenching superoxide and singlet oxygen. Waxed papers, butylatedhydroxy toluene impregnated packaging materials and tocopherols, essential fatty acids, and plant extracts obtained from plants such as rosemary, oregano, and tea have been used in antioxidant spreading systems. Vitamins E and C may be used in these systems in recent years because of their anti-oxidative effects. In a study, it was determined that lipid oxidation decreased in whole-fat milk powder that was active-packaged by using α-tocopherol.

3. Intelligent Packaging

Intelligent food packaging is defined as materials that can monitor the conditions of food and the surrounding environment. This technology, also known as smart labels, provides information to the producer, seller, and consumer about changes in food during transport and storage of the product. For this purpose, various sensors and indicators are used by being integrated into the package or directly adhered to the package and they provide information about the product characteristics such as freshness, shelf life and usage conditions. The working principle of these sensors and indicators is generally based on temperature-time measurements and the measurement of changes in chemical and microbiological properties. Intelligent packaging technology provides information on the product in a short time, thus providing an alternative to time-consuming and costly analysis.

Sensors

Sensors are units that generally detect changes in the atmosphere within the product or packaging itself and transfer it to the manufacturer, seller, and consumer. The sensors consist essentially of a receptor and a transducer. It is possible to examine the sensors used in smart packaging under different headings as biosensors, gas sensors, chemical sensors, and pathogen sensors.

Biosensors

Devices that detect, record, and transmit the biological reactions occurring in food packages are called biosensors. Biosensors, like other sensors, consist of a bioreceptor and energy-converting devices (transducers). Bioreceptors are responsible for detecting the target parameter, usually organic materials such as various enzymes, antigens, hormones, and nucleic acids. Transducers consist of electrochemical, optical, or calorimetric systems and convert biological signals into measurable electrical messages.

Gas sensors

It is important that the gas mixture in the package does not change until it reaches the consumer, particularly in products packaged using modified atmosphere packaging systems, to maintain the quality of the product. Gas sensors are systems that detect and transmit the presence or absence of gases used in modified atmosphere packaging, packaging integrity, and leaks. O_2 and CO_2 sensors are the most commonly used gas sensors.

Chemical sensors

Chemical sensors detect the presence of a specific chemical or gas in the packaged product or in the headspace of the package. The substance detected by chemical sensors is converted into signals by transducers and enables the consumer to perceive the presence of the substance.

Pathogen sensors

They are used for the detection of pathogenic microorganisms that infect the packaged products after production. Antibodies are generally used for this purpose and visual warning appears in the package as result of the reaction of these antibodies with the pathogens present in the product.

Indicators

Indicators used in intelligent packaging technology indicate the presence, concentration, or deficiency of a particular substance, particularly by color changes. They are generally classified as freshness indicators, time-temperature indicators (TTI), integrity indicators, and Radio frequency information device (RFID).

Freshness indicators

The freshness indicators are generally used in products packaged with modified atmosphere packaging technology, which informs the consumer of the change in gas composition in the package through the label printed on the package. If the necessary conditions are not met during the transportation and storage of foods, some microbiological spoilage may occur in the product and as a result of this deterioration, metabolites such as CO_2, SO_2, NH_3 and ethanol are formed. Freshness indicators identify these metabolites and change the colour of the label on the packaging, thus providing information about the quality of food. When classified according to working principles, it is possible to list the most frequently used freshness indicators as indicators; sensitive to pH change, volatile compounds, hydrogen sulfide (H_2S), and various microbial metabolites.

***Time-Temperature indicators* (TTI)**

Time-temperature indicators (TTI) detect physical, chemical, enzymatic, and microbial deteriorations in the product due to the exposure of the products to temperatures that they should not be exposed to during transport and storage. They are particularly effective in controlling temperature changes in refrigerated or frozen foods such as milk and dairy products. In case of temperature change, the barcode on the packaging turns into a dark colour, thus it prevents the data transfer when the barcode is scanned and prevents the sale of the product. It is possible to classify the most commonly used time-temperature indicators as polymer, diffusion, and enzymatic-based ones. Time-temperature indicators can be used for all types of food products, including milk and dairy products.

4. Edible coatings and films

Edible films and coatings become very interesting concept not only because of their benefits on food product but also in novel product differentiation and its launching on the market. Coatings are aimed to have similar functions as those of conventional packaging with great ability to act, as barriers to water vapour, gases, and flavour compounds. The main disadvantage is that they cannot be used as the only packaging, in other words secondary non-edible packaging is required in order to properly and hygienically handle packed foodstuff. Besides mentioned, they are often used as carriers of different active compounds that can act as antimicrobials, antioxidants or nutraceuticals. Being isolated from natural sources edible coatings can be classified according to their main structuring molecules to protein based, polysaccharide based, resins and lipid based used alone or together. The addition of plasticizers or/and surfactants is often required. Within dairy products, edible packaging materials are mostly used for cheese. Besides, providing better quality and preserving freshness, edible packaging could significantly reduce the ultimate costs of cheese packaging by reducing the amount of usually required packaging material. It is important that the applied coatings need to be neutral considering sensory characteristics as they could influence or interfere with sensory properties characteristics of the packaged cheese.

In the group of polysaccharides, galactomannan and chitosan were used as cheese coatings. Galactomannan coatings significantly reduced respiration rates and mould growth on the cheese surface that was significant in uncoated cheese samples. In general, protein-based films have more interesting mechanical and barrier properties than those consisting of polysaccharides. Many protein materials such as collagen, corn zein, wheat gluten, soy protein isolate, fish proteins, ovalbumin, whey protein isolate and casein have been tested. Milk proteins, like casein, become very interesting not only because of their good properties but also because of their industrial surplus. Proteins isolated from milk have great nutritional value, also they have some useful physical characteristics like solubility in water and emulsifying properties that makes them great choice as edible coating.

5. Nanotechnology

Nanotechnology implies the use of materials on a nanometric scale, below 100 nm in size. Nanoparticles are aimed to improve some properties of existing packaging materials such as mechanical, thermal and barrier properties. Nanoparticles are frequently used in active releasing systems. They can be carrier of antibacterial compounds that are then immobilized in the polymer matrix and coated on the product surface. Controlling storage conditions, triggered release of active agents occur. The potential application for a given nanoparticle depends on many factors like the material type, the particle shape and the applied concentration.

Nanotechnology can be used in food packaging in three ways (Duncan, 2011):

1. To produce synthetic polymer and biopolymer-based packaging materials to develop packages with better barrier and mechanical properties.
2. To develop active packaging materials by using nanoparticles having antimicrobial properties or oxygen absorption, such as Ag, ZnO, and TiO_2.
3. To detect the storage conditions in which food products are exposed by use of different nanoparticles such as Fe_2O3 and TiO_2 in intelligent packaging technology and to produce markers that inform the manufacturer, seller and consumer.

Even though metal-based nanoparticles have shown great antibacterial activity such systems might be unacceptable from a commercial point of view because their effects on human health and the environment on long term has not been clarified so far. For this reason packaging systems containing food grade nanoparticles may be more desirable, such as sorbic acid that is legally accepted and food grade antimicrobial.

In the dairy sector, one of most frequently used properties of nanotechnology is enhancement of oxygen barrier properties of nano laminates, nanocomposite bottles and bins with silver nanoparticles. Nanoclays and nanocrystals embedded in the plastic films and bottles are shown to block oxygen, carbon dioxide and moisture transfer thus avoiding them to reach packed food products. The advantage of clay nanocomposite in the packaging material is that it offers better shelf life, shutter proof, these materials are lighter in weight and heat resistant .This feature was achieved by incorporating silver- based microparticles with bactericidal, antimicrobial and self-sterilizing properties into the rigid plastic bottles used as packaging for the milk. The microparticles are included as a powder in the polyethylene preform that is used to make plastic bottles by blow or injection moulding. The microparticles are inert, so there is no risk of their detaching from the packaging and coming into contact with the milk. Furthermore, in the domain of smart packaging, plastic materials with incorporated nanosensors are aimed to detect off-flavours and gases produced by food item when it spoils and the packaging itself changes colour to emit an alert.

6. Biodegradable packaging

One challenge facing the food packaging industry is the efforts given to produce biobased – primary packaging that is at the same time biodegradable but also that matches the durability of the packaging with product shelf life. The biggest issue is how to make the biologically based packaging material, that by its nature is aimed to degrade naturally during certain period, but in this case, it must remain stable without changes of mechanical and / or barrier properties and must function properly during storage until disposal. Subsequently, the material should biodegrade efficiently after discarding.

The most used material in this group is polylactic acid (PLA) that is currently used for production of different packaging shapes (cups, bowls, foils, and food storage containers). Foamed PLA is used as an insulator and is an alternative to foamed polystyrene (PS). PLA has good mechanical properties, similar to polyethylene terephthalate (PET) and polypropylene (PP). Additionally, an important component is the plasticizer, which enhances flexibility and extensibility. These coatings exhibit higher water permeability, lower oxygen permeability, and inferior mechanical properties compared with traditional packaging. Gliadin films cross-linked with cinnamaldehyde (5 %) and enriched with natamycin (0.5 %). Cast films were used to pack slices of soft and semi-hard cheeses extending their shelf life due to fungistatic action of cinnamaldehyde.

Conclusion

The packaging methods used in the dairy industry are increasingly changing to meet the needs of consumers and the rest of the food industry. The new packaging concepts for dairy products cover many possibilities that allow not only protection, but also the extension of the shelf life and / or the improvement of the functional properties of the products. Some of the recently introduced methods are mature enough to reveal information about the freshness of the product. These innovative approaches also increase the safety of dairy products, and as their commercialization progresses, it is almost safe to say that the number of complaints from distributors and consumers will decrease. Therefore, more studies are required on the use of new packaging systems and processing methods to expand and improve food safety. Advanced technology will continue to enable the dairy industry to meet consumer needs for food safety, quality, cost, information and environmental concerns with food packaging in the global marketplace.

HAZARD ANALYSIS CRITICAL CONTROL POINTS CONCEPT FOR FOOD PROCESSING INDUSTRY

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Good Hygienic Practices (GHP)

Good Hygienic Practices/GHP follows general hygienic rules and applies recognized hygienic principles as well as laws and regulations issued by the competent authorities, referring to food and food products, equipment, premises and personnel. The GHP schemes are not factory specific and could be applied to all types of food processing plants. They are intended to establish and maintain acceptable hygienic standards in relevant food operations. More emphasis is should be given to milking hygiene at farm level and processing hygiene for milk products manufacturing enterprises. However in principle, GHP schemes remain interchangeable for similar types of food plants. This includes, sanitation measures (e.g. periodic cleaning and disinfection of food cutting boards), personal hygiene, specific preventive measures to avoid cross contamination (e.g. plant internal transports of raw materials and finished products must not cross each other), specific food handling procedures (e.g. food containers must not directly be placed on the floor, but on stands, pallets etc.).

GHP for milk food processing plants refers principally to:

- Raw materials that meet hygiene quality standards
- Appropriate milk plant layout and sanitary design of equipment used for milk processing.
- Processing methods that allow safe handling of food.
- Appropriate waste and pest control measures
- Appropriate sanitation procedures (cleaning and disinfection)
- Compliance with potable water criteria
- Functional cold chain
- Regular examination of health and personal hygiene of staff
- Regular training of staff on hygiene equirement

PRIMARY PRODUCTION

Hygienic production of food source

Food animals reared should be managed in such a way to ensure that milk obtained from them is safe and wholesome for the consumers. Hygienic production will start from the farm level. The potential effects of primary production activities on the safety and suitability of food should be considered at all times, this includes identifying any specific points in such activities where a high probability of contamination may exist and taking specific measures to minimize that probability. The farmers should take every step to control contamination from air, soil, water, feedstuffs, fertilizers (including natural fertilizers), pesticides and veterinary drugs, or any other agent used in the primary production. Control plant and animal health so that it does not pose a threat to human health through food consumption, or adversely affect the suitability of the food product. Protect food sources from faecal and other contaminant. It is essential that certain ground rules are followed. Pasture land and land used for fodder production should not have previously been contaminated with heavy metals, industrial chemicals or environmental waste. Animal sheds should be kept clean and adequate control should be instituted with respect to the animal feed which can lead to serious problems in the food chain subsequently. Farmers should control production so that contamination of the crops, proliferation of pests and disease of animals and plants, donot compromise food safety. Good Agriculture Practices (GAP), Good Animal Husbandry Practices (GAHP) including Good Hygienic Practices (GHP) where appropriate, should be adopted to make sure that the milking animals and non-milk ingredients used in milk products will not present a food hazard to the consumer. Care should be taken to manage wastes and store harmful substances appropriately. If commodity is to be stored on the farm then Good Storage Practices (GSP) should be followed. Potential sources of contamination from the environment should be considered *i.e.* parasitic, bacterial, viral, pest, pesticide and heavy metals during production at farm level. On-farm programmes which achieve specific food safety goals are becoming an important part of primary production and should been couraged.

Handling, Storage and Transport

Procedures should be in place to sort food and food ingredients and to segregate material which is evidently unfit for human consumption. Dispose off any rejected material in a hygienic manner and protect food and food ingredients from contamination by pests or by chemical, physical or microbiological contaminants or other objectionable substances during handling, storage and transport. Care should be taken to prevent, so far as reasonably practicable, deterioration and spoilage through appropriate measures which may include controlling temperature, humidity, and/ or other controls.

Cleaning, Maintenance and Personnel Hygiene at Primary Production

Appropriate facilities and procedures should be in place to ensure that any necessary cleaning and maintenance is carried out effectively and an appropriate degree of personnel hygiene is maintained.

ESTABLISHMENT, DESIGN AND FACILITIES

Location and plant layout for a milk plant

The factory should be located in such an area free from flooding, dumping of litter and infestation of pests and air free from dust and other pollutants. The orientation of the building should be such that the prevailing winds do not blow directly into manufacturing area. The area immediately around the factory should be fully tarred or smooth cemented or covered with deep layer of gravel or stones, this will help in weed control. Other areas should be covered by grass to minimize dust formation and accumulation of dust. The area around the factory should be free from water purification and wastewater treatment plants which produce infected aerosols of concentrated organisms. Every section of the plant should be designed and located (either within the factory or outside the factory) in such a manner to provide proper cross ventilation and minimize cross contamination. The entrance to the plant should be through foot dips and dark tunnels. The building exterior should be designed, constructed, and maintained to prevent entry of contaminants and pests. There should be no unprotected openings located in the roof or walls. While designing milk processing plant care should be taken to see that milk flow are unidirectional i.e. from unclean area to clean area and back tracking should be avoided, spacing between the processing lines should be enough to facilitate easy movement of personnel sand easy cleaning. Facilities for collection/disposal of by-products and wastes should be provided. Drainage flow should be from clean to dirty area and air flow must be from clean to unclean area. The drainage should be of U type with proper gradient for easy flow and it should be provided with proper gratings. Adequate natural or artificial lighting must be provided throughout the processing plant should be provided with well distributed light with overall intensity should not be less than 540 lux at all inspection point, not less than 220 lux in work rooms and not less than 110 lux in other areas. Adequate ventilation should be provided to prevent excessive heat and to prevent the accumulation of odour, dust etc. the construction of slaughtering and dressing unit should be so designed that there is no access of direct sunlight on the dressed carcasses.

Internal Structure and Fittings

Doors and Windows – Windows should be designed for easy cleaning, minimize the buildup of dirt and where necessary, be fitted with removable and cleanable insect screens. Doors should have smooth, non-absorbent surfaces, which are easy to clean and to disinfect if required. The building should be adequately protected by having self-closing doors against the entry of rodents, insects, birds and other animals. Doors can be made of aluminum and stainless steel, fiber glass, or glass reinforced plastic. The exterior doors should not open directly into production areas and should remain closed when not in use. Window sills should not flush with the wall, the internal sills can be sloped 20-40 degree to prevent their use as temporary storage places and external sills to be sloped at 60 degree to prevent birds roosting. Windows should be free from any ledges and protrusions which could collect dust. The windows panel preferably can be made of easily unbreakable, transparent materials like acrylic sheet.

Floors and Walls – The floors can be either tilled or epoxy laid. They should be non-slippery, food grade, alkali and acid resistant and can be cleaned as required. The floors should be drainable and resistant to acid, alkaline and product residues and can be fitted with stainless steel drainage systems and covered with easily removable stainless steel fitted gratings for regular cleaning. Internally the walls should be tiled or stainless steel paneled up to a minimum height of two to three meters with smooth, non-porous and crevice free surface that can be washed easily. The surfaces of walls, partitions and floors should be made of impervious and non-toxic materials. Ceilings and over head fixtures should be constructed and finished in a manner to minimise the dirt formation, condensation and shedding of particles. The floors should have round corners or covings which facilitate easy cleaning and prevent the accumulation of dirt in the corners.

Equipments: Machinery and other equipments should be made of food quality rust proof stainless steel. Machinery coming in contact with food, should be designed and constructed in such a way they can be easily cleaned, disinfected and maintained to avoid the contamination of food. Machinery should be properly designed for easy dismantling and assembling for cleaning purposes and should be obtained from the reputed manufacturers in the world. Two to three feet clear working area around the equipment should be provided, so persons could reach easily to carry effective cleaning. Where necessary, equipment should be durable and movable or capable of being disassembled to allow for maintenance, cleaning, disinfection, monitoring and for example to facilitate inspection for pests. The equipment should be located or should have sufficient ground clearance to facilitate proper cleaning.

Milk food control and monitoring equipments:

According to the nature of the milk processing operations adequate facilities should be provided for heating, cooling, cooking, refrigerating, and freezing and for storing of food to achieve the required food temperatures rapidly as necessary in the interest of the food safety and suitability. Equipments should have effective means for controlling and monitoring humidity, airflow and any other characteristics likely to have a detrimental effect on safety or suitability on foods. These requirements are intended to ensure that the Un-desirable and harmful microorganisms or their toxins are eliminated or reduced to safe levels or their survival and growth are effectively controlled. Monitoring devices should be installed as required and recordkeeping to be carried out round the clock to monitor the critical limits established in HACCP based plans. Monitoring equipments should be calibrated at regular intervals or whenever necessary.

Facilities

Water: Water that comes in contact with milk and milk products should be portable as specified in the WHO guidelines for drinking water quality or water of a higher standard. Non potable water can be used for steam production, fire control, refrigeration and other similar purposes and they should not constitute a hazard to the safety of food. Adequate drainage and waste disposal facilities should be designed and provided to avoid the risk of contaminating food or the potable water supply. Water recirculated for reuse should be treated and maintained to avoid risk to the safety and suitability of food. The water treatment process should be effectively monitored. The storage tanks for water should be cleaned at regular intervals and it should be properly documented. Hot water should be provided with minimum temperature of 82°C for sterilization of the utensils, other equipments and for cleaning purpose. The potable and non-potable water pipelines should be properly colour coded.

Workers amenities: Personnel hygiene facilities should be made available to maintain an appropriate degree of personal hygiene to avoid contaminating food. Adequate facilities for changing clothes, individual locker, lavatories of appropriate hygienic design (one per 10-20 employees), hand washing(one per 20-25employees), which should be knee/elbow/sensor operated), soap dispensers, plane mirror, hand dryer and supply of hot and coldwater. Such facilities should be suitably located and designated. Cleaning and disinfecting of the amenities should be monitored and documented.

Cleaning facilities**:** Adequate facilities, suitably designated, should be provided for cleaning food, utensils and equipment. Such facilities should have an adequate supply of hot and cold potable water where appropriate.

Air quality and ventilation**:** adequate facilities for natural or mechanical ventilation should be provided to maintain proper temperature, control odors, control humidity, and minimize air borne contamination from aerosols and condensed droplets. Ventilation systems should be designed and constructed in such a way that air does not flow from contaminated areas to clean areas. The ventilation system should have provision for self-opening and closing.

Lighting: the glassed area should be approximately one fourth of the floor area of the work room. Adequate natural or artificial lighting should be provided to enable the undertaking to operate in a hygienic manner. Where necessary, lighting should not be such that the resulting colour is misleading. The intensity should be adequate to the nature of the operation. Lighting fixtures should, where appropriate, be protected to ensure that food is not contaminated by breakages.

Storage**:** adequate facilities for the storage of milk, non-ingredients and non-food chemicals (e.g. cleaning materials, lubricants, fuels) should be provided. Where appropriate, food storage facilities should be designed and constructed to permit adequate maintenance and cleaning, avoid pest access and harborage, enable food to be effectively protected from contamination during storage, and where necessary, provide an environment which minimizes the deterioration of food (e.g. by temperature and humidity control). The chiller room temperature for milk and milk products should be maintained between +0to +4°C and in freezer room should be maintained at or below - 18°C.The type of storage facilities required will depend on the nature of the f o o d . Where necessary, separate, secure storage facilities for cleaning materials and hazardous substances should be provided. It is always better to store veg and non-veg separately to prevent cross- contamination. Storage of raw material should be subjected to FIFO (first in first out).

CONTROL OF OPERATION

Control of food hazards

Food business operators should control food hazards through the use of systems such as HACCP. They should:

- Identify any steps in their operations which are critical to the safety of food
- Implement effective control procedures at those steps
- Monitor control procedures to ensure their continuing effectiveness
- Review control procedures periodically and whenever the operations change
- These systems should be applied throughout the food chain to control food hygiene throughout the shelf-life of the product through proper product and process design.
- Control procedures may be simple, such as checking stock rotation, calibrating equipment, or correctly loading refrigerated display units. In some cases a system based on expert advice and involving documentation may be appropriate

Key Aspects of Hygiene Control System

Time and temperature control*:* Inadequate food temperature control is one of the most common causes of food borne illness or food spoilage. Such controls include time and temperature of cooking, cooling, processing and storage. Systems should be in place to ensure that temperature is controlled effectively where it is critical to the safety and suitability of food.

Temperature control systems should take into account the following-

The nature of the food e.g. its pH, water activity, and likely initial level and types of microorganisms, what is the intended shelf-life of the product, the method of packaging and processing and how the product is intended to be used, e.g. further cooking/processing or ready- to-eat. Such systems should also specify tolerable limits for time and temperature variations. Temperature recording devices should be checked at regular intervals and tested for accuracy.

Microbiological and other specifications: Microbiological testing is ineffective for routine monitoring but can be used as a verification tool. Microbiological testing can be used to determine

e.g. during verification audits or on periodic basis that the overall operation is under control. Microbiological, chemical or physical specifications are used in any food control system, such specifications should be based on sound scientific principles and state, where appropriate, monitoring procedures, analytical methods and action limits.

Microbiological cross-contamination: Pathogens can be transferred from one food to another, either by direct contact or by food handlers, contact surfaces or the air. Raw, unprocessed food should be effectively separated, from ready-to-eat foods. Access to processing areas may need to be restricted or controlled. Where risks are particularly high, access to processing areas should be only via a changing facility. Personnel may need to be required to put on clean protective clothing including footwear and wash their hands before entering. Surfaces, utensils, equipment, fixtures and fittings should be thoroughly cleaned and where necessary disinfected after raw food, particularly milk and meat, has been handled or processed. Separate culinary should be used for handling raw milk and ready-to-eat milk products.

Physical and chemical contamination: Systems should be in place to prevent contamination of foods by foreign bodies such glass, wood, metal, plastic, pests, building materials, grease or metal pieces from machinery, dust, harmful fumes and unwanted chemicals. In manufacturing and processing, suitable detection or screening devices should be used where necessary. Filtering, sifting, metal detection, air separation, magnets, washing, floatation, visual inspection, exclusion of glass and timber materials, preventive maintenance of equipments are some of the control measure we can follow to prevent physical contamination.

Raw Material Receiving Inspection:

No raw material or ingredient should be accepted by an establishment if it is known to contain parasites, undesirable micro-organisms, pesticides, veterinary drugs or toxic, decomposed or extraneous substances which would not be reduced to an acceptable level by normal sorting and/or by processing.

Milk: Once a lot of milk is supplied by the supplier/ milk plant for product making, 100% physical inspection for parameters such as foreign matter contamination, spoilage, off color, off odour and whether is being supplied at the prescribed temperature should be done and should be subjected to microbiological test for conformation to the stated standard. The sample should be tested for chemical properties as per the company standards for the types of particular raw milk

Other Ingredients: all impetrated and local ingredients such as protein binders, spices , packing materials, chemical additives like iodinated salt, preservatives, sweeteners, flavor enhancers, colour set suppliers should be advised to provide health/test certificates for the conformity for the batch supplied and these materials should be subjected to one or several of tests for physical, microbiological and chemical as appropriate to verify the status of the certificate provided along with the supply. Only sound, suitable raw materials or ingredients should be used. Stocks of raw materials and ingredients should be subject to effective stock rotation.

In-process Inspection: The special emphasis should be paid to GMP and HACCP techniques adopted at in-process stage. This should include personnel hygiene tests i.e. test for stool and nasal swabs for possible pathogen. If detected positive such personnel should be taken away from the foodhandling operations and subject to medical treatment till conforming to safe food handling. The cleaning of the processing premises, utensils and also the personnel cleanliness should be checked at least once in a month at the critical points identification by the swab sampling scheme. Monitoring the effectiveness of the cleaning procedure should be supervised round the clock according to the cleaning schedules and check lists. Pest control is also considered as one of the major aspects in-process inspection.

Packaging

The packaging material used for milk and milk products should be grease proof, should have sufficient tensile strength and tearing resistance during handling and cold storage. The package should not impart or allow picking up any foreign odour or flavouring by milk. Packaging materials or gases where used must be non-toxic and not pose a threat to the safety and suitability of food under the specified conditions of storage and use. Where appropriate, reusable packaging should be suitably durable, easy to clean and disinfect.

Water

Only potable water, should be used for milk processing, with the following exceptions for steam production, fire control and other similar purposes not connected with milk and milk products. Non potable water in certain milk food processing area provided this does not constitute a hazard to the safety and suitability of milk and milk products. Ice used as an ingredients in milk products and steam which come in direct contact with milk or food contact surface should be produced, handled and stored to protect them from contamination. Ice and Steam used in direct contact with food or food contact surfaces should not constitute a threat to the safety and suitability of food.

Management and Supervision

The control measures and supervision needed will depend on the size of the business, the nature of its activities and the types of milk food produced. Managers and supervisors should have enough knowledge of food hygiene principles and practices to be able to judge potential risks, take appropriate preventive and corrective action and ensure that effective monitoring and supervision takes place.

Documentation and records

Record keeping is an essential part of the HACCP process. It demonstrates that the correct procedures have been followed from the start to the end of the process, offering product traceability. It provides a record of compliance with the critical limits set, and can be used to identify problem areas. Records that should be kept include: all processes and procedures linked- to GMP, GHP, and CCP monitoring, deviations, and corrective actions. Examples of records include: Temperature logs of cold rooms, platform test records, pasteurization time-temperature records, products records, personnel hygiene records, medical records, pre-operational sanitation checks, equipment calibration, training, receiving inspection records, transportation records, etc .Documents should also include those that recorded the original HACCP study, e.g. hazard identification and selection of critical limits, but the bulk of the documentation will be records concerned with the monitoring of CCPs and corrective actions taken. Records keeping can be carried out in a number of ways, ranging from simple check-lists, to records and control charts.

Manual and computer records are equally acceptable, but a documentation method should be designed that is appropriate for the size and nature of the enterprise. Records provide retrospective proof that may be required to prove due diligence. Records should be reviewed and verified by a competent person from time to time. Any deviations on the daily records should trigger additional reviews. Anomalies must also be reviewed for potential problems or trends. Where necessary, appropriate records of processing, production and distribution should be kept and retained for a period that exceeds the shelf-life of the product. Documentation can enhance the credibility and effectiveness of the food safety control system.

Recall procedures

Managers should ensure that effective procedures are in place to deal with any food safety hazard and to enable the complete, rapid recall of any implicated lot of the finished food from the market. Where a product has been withdrawn because of an immediate health hazard, other products which are produced under similar conditions, and which may present a similar hazard to public health, should be evaluated for safety and may need to be withdrawn. The need for public warnings should be considered. Recalled products should be held under supervision until they are destroyed, used for purposes other than human consumption, determined to be safe for human consumption, or reprocessed in a manner to ensure their safety.

TRAINING

Training is the most primary requirement to ensuring safe food all. It can be dubbed as a prerequisite to food safety. Trainings can be conducted on the shop floor, or in a classroom setting whatever serves best for your organization. The interval for these training has not been given specifically by FSSAI but ideally should be every 3 months atleast & every time a new employee is recruited. The effectiveness of these trainings must be evaluated too. All trainings must be regularly reviewed and updated and schedules and records must be appropriately documented and maintained.

Awareness and responsibilities

All personnel working in milk plant should be aware of their role and responsibility in protecting milk and milk products from contamination or deterioration. Milk handlers should have the necessary knowledge and skills to enable them to handle milk and milk products hygienically. Those who handle strong cleaning chemicals or other potentially hazardous chemicals should be instructed in safe handling techniques.

Training programmes

A training schedule should be documented &implemented. Trainings for food handlers should be conducted on recruitment of staff and regularly to understand their roles &responsibilities, food hygiene &food safety concepts. Assessment of the effectiveness of trainings should be carried out. Training programmes should be reviewed and updated regularly. Factors to take into account in assessing the level of training required include, the nature of the food, the manner in which the food is handled and packed, the extent and nature of processing or further preparation before final consumption, the conditions under which the food will be stored and the expected shelf life of the product.

Instruction and supervision

Periodic assessments of the effectiveness of training and instruction programmes should be made, as well as routine supervision and checks to ensure that procedures are being carried out effectively

Refresher training

Training programmes should be routinely reviewed and updated where necessary. Systems should be in place to ensure that food handlers remain aware of all procedures necessary to maintain the safety and suitability of food.

FOOD SAFETY AND STANDARDS ACT, 2006

Dr. Anu. Joseph
Food Safety Officer
Office of the Assistant Food safety Commissioner, Thrissur

The food industry was governed by the provisions of prevention of food adulteration Act 1952.The food safety and standard bill was passed by the Parliament in monsoon session and approved by President in September 2006. After making the rules and regulations the Act was implemented with effect from 5th August 2006.

Food Safety Standards Act 2006

An Act to consolidate the laws relating to food and to establish the Food Safety and Standards Authority of India for laying down science based standards for articles of food and to regulate their manufacture, storage, distribution, sale and import, to ensure availability of safe and wholesome food for human consumption and for matters connected therewith or incidental thereto.

The food safety and standards act integrates the following Acts and orders

1. Vegetable Oil Products Order, 1947

2. Prevention of Food Adulteration Act 1954

3. Fruit Products Order 1955

4. Solvent extracted oil, De-oiled meal and Edible flour (control) order. 1967

5. Meat Food Products Order, 1973

6. Edible Oils Packaging (regulations) Order. 1988

7. Milk and Milk Products order 1992

Objectives of the Act

1. To consolidate the laws relating to food

2. To establish food safety and standards authority of India for laying down science based

Standards for articles of food.

3. To regulate the manufacture, storage, distribution, sale and import of food.

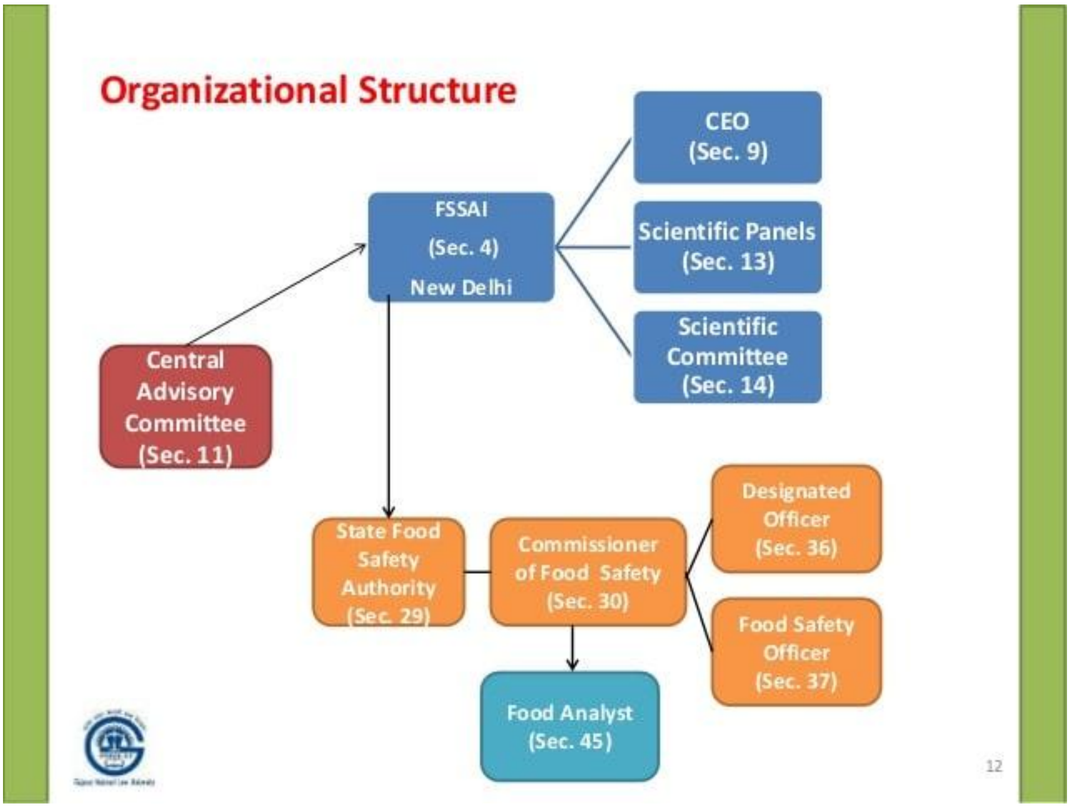
4. To ensure availability of safe and wholesome food for human consumption

Food Safety and Standards Authority of India (FSSAI)

Food Safety and Standards Authority of India (FSSAI) is a statutory body established under the Ministry of Health & Family Welfare, Government of India. The FSSAI has been established under the Food Safety and Standards Act, 2006, which is a consolidating statute related to food safety and regulation in India. FSSAI is responsible for protecting and promoting public health through the regulation and supervision of food safety.

The FSSAI has its headquarters at New Delhi. The authority also has 6 regional offices located in Delhi, Guwahati, Mumbai, Kolkata, Cochin, and Chennai. 14 referral laboratories notified by FSSAI, 72 State/UT laboratories located throughout India and 112 laboratories are NABL accredited private laboratories notified by FSSAI.

Organisational structure of fssai



Definitions as per FSS act

"Food" means any substance, whether processed, partially processed or unprocessed, which is intended for human consumption and includes primary food, to the extent defined in clause (ZK) genetically modified or engineered food or food containing such ingredients, infant food, packaged drinking water, alcoholic drink, chewing gum, and any substance, including water used into the food during its manufacture, preparation or treatment but does not include any animal feed, live animals unless they are prepared or processed for placing on the market for human consumption, plants prior to harvesting, drugs and medicinal products, cosmetics, narcotic or psychotropic substances: Provided that the Central Government may declare, by notification in the Official Gazette, any other article as food for the purposes of this Act having regards to its use, nature, substance or quality.

"**Food safety**" means assurance that food is acceptable for human consumption according to its intended use.

"**Standard**", in relation to any article of food, means the standards notified by the Food Authority.

Salient features of FSS act 2006

- Emphasis on gradual shift from regulatory regime to self-compliance through food safety management systems
- Enforcement of act by the (i) central licensing authority (ii) state licensing and registration authority in each state/ UT through state Food Safety Commissioners, Designated Officers and Food Safety Officers for licensing, inspections and sampling.
- No license for petty food business operators- only registration is mandatory
- A single license for one or more articles of food and also for different establishment / premises in the same area.
- Regulation of food imported in the country
- Harmonisation of domestic standards with international food standards
- Covering health foods, food supplements, nutraceuticals
- New justice dispensation system for fast track disposal of cases of contravention and compensation in case of injury or death of the consumer
- Graded penalty depending on the gravity of offences for selling food not of the nature/ substance or quality, substandard food, misbranded food including misleading advertisement.
- A single reference point for all matters relating to food safety and standards, by moving from multi-level, multi- departmental control to a single line of command.
- Reduction in court cases by adjudication procedure
- FSMS plan and food recall system

Fssai issue three types of licenses

- Registration: For turn over less than 12 lakhs per year
- State License: For turn over between 12 lakhs and 20 crores
- Central license: For turn over more than 20 crores

Validity of Fssai license

Validity & Renewal After approval of the food License from FSSAI, generally, it is issued with a validity of one year to Five years as chosen by the food Business Operator from the date of issue of registration or license subject to remittance of fee applicable for the period and compliance with all conditions of license. Before expiry, if the license, it can be renewed for another one year to five as the case may be, not later than 30 days prior to the expiry date indicated in the license years based on the requirements of the license holder any renewal application filed beyond the period mentioned after the expiry date, shall be accompanied by a late fee of Rs.100 per day for each day of delay.

Food Safety Management System

A series of sector specific Food Safety Management System (FSMS) Guidance Documents have been developed/underdevelopment with the intent to provide implementation guidance to food businesses (especially the small and medium businesses) involved in manufacturing, packing, storage and transportation to ensure that critical food safety related aspects are addressed throughout the supply chain.

These documents are based on Schedule 4 of Food Safety & Standards (Licensing & Registration of Food Businesses) Regulation, 2011 and lay down general requirements on good hygienic practices to be followed by Food Business Operators & indicate practical approaches which a business should adopt to ensure food safety. The documents are recommendatory in nature and also provide the basic knowledge and criteria for implementation of Hazard Analysis and Critical Control Point (HACCP) system by the food businesses. Sample HACCP Plans have been taken from some established practising industries. These plans could be used as reference by the industry and modified or altered based on their operations.

QUALITY TIME MANAGEMENT

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The bad news is that time flies. The good news is that you're the pilot. - *Michael Altshuler*

Time management is really *task management*. **We cannot really manage time as we all have the same 24 hours and it will not slow down for us, we choose the tasks we do, consciously or by default!**

Before we explore time management strategy, it will be ideal if we look back on how we currently spend or prioritize our time. Do we want to spend time for health, wealth, or quality time with family?Is our priority just enjoying the present moment or a more serious purpose-driven life?

The importance of Time Management came to the forefront with the Industrial Revolution of the 19th Century mainly from the need to increase productivity in factories.

Initially Time Management was all about rationally and mechanically sequencing activities to maximize the output. Stephen R. Covey popularized the Eisenhower's Time Management Matrix in his book The 7 Habits of Highly Effective People. Managing time itself is no

	Urgent	Not Urgent
Important	**Quadrant I** • Crisis • Pressing problems • Deadline driven projects	**Quadrant II** • Relationship building • Finding new opportunities • Long-term planning • Preventive activities • Personal growth • Recreation
Not Important	**Quadrant III** • Interruptions • Emails, calls, meetings • Popular activities • Proximate, pressing matters	**Quadrant IV** • Trivia, busy work • Time wasters • Some calls and emails • Pleasant activities

longer the aim, but managing where to focus at any particular time. Covey's Time Matrix helps us to **devote attention and time to activities in accordance with their importance and urgency**.

Quadrant II is called the quadrant of quality and effectiveness.
We can sort the task in categories like actionable, non-actionable, or in-progress. In our to-do list, we must add all the tasks which are actionable and can be done easily by ourselves. A

good to-do list must be detail-oriented. The list could contain the task and other details in it like when and how we are going to complete these tasks.
We can train our staff in a way that they can are equipped to handle and solve some tasks without help. If any assistance is needed, it should be related to our expertise and not some unimportant work. When staff is trained better, they can perform tasks efficiently so we will not worry about their stuff and more time can be invested in our work.
If we have read the book which is called 80/20 rule, we will understand that 20% of our actions will result in 80% of productivity. This means that 80% of other tasks are less important. When we are short of time, we can easily decide which tasks we should prefer. We can focus on the tasks which are giving us more result (high priority) rather than selecting the task which are giving little result (low priority).
Erin Meyer in "The Culture Map" describes eight dimensions of behavior Gaps between countries. Under Scheduling, she talks about linear time and Flexible time. While the former gives importance to the Clock time the latter is concerned about the event time. Thus when working in groups or teams, it would be wise to be aware of different time perspectives between people.

We can conclude with Simon Sinek's book "Start with Why":

WHY

Why improve our time management? To enjoy life more, in the present and achieve more in the future, both at work and at home. That's why!

WHAT

What is time management? It is **maximising the time we spend on the important things**… by minimising the time we spend on the *unimportant* things. This requires identifying the important/unimportant things, which is tricky but doable, with a little bit of analysis and thinking.

HOW

Minimise the time spent on unimportant things by

1. Drop selectively - say No!
2. Delegating more, doing only part and getting others to help.

3. Delay certain tasks that are can be procrastinated on purpose.
4. Do only important and urgent things, and focus on important things!

Find a system that works. Everyone has a different preference for how they could develop or adjust to organizing their time. Some like to carry written to-do list checking off items as they go. Others find it convenient to schedule tasks on their phones to receive automated reminders. The sole purpose of Time Management is to make sure that you get your duties and responsibilities done along with everything else you need to feel fulfilled within a fixed timeframe! It also good to ensures that whatever you're doing throughout the day is being done with your wellbeing in mind - this is key!

Balance is essential to prevent burn out, mistakes and frustrations. What most of us busy people need is a shot of rejuvenation! Short naps have shown to substantially enhance both creativity and productivity. It has also been shown to lower the risk for heart attacks and strokes. Scheduling time away from work helps us not only to be more productive with our work but also have that balance we are looking for between work and our private lives. Carving time for personal hobbies, exercise and spirituality will improve quality time in our family life. What most of us strive for is a life of good work we are proud of and a personal life that has quality and meaning.

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