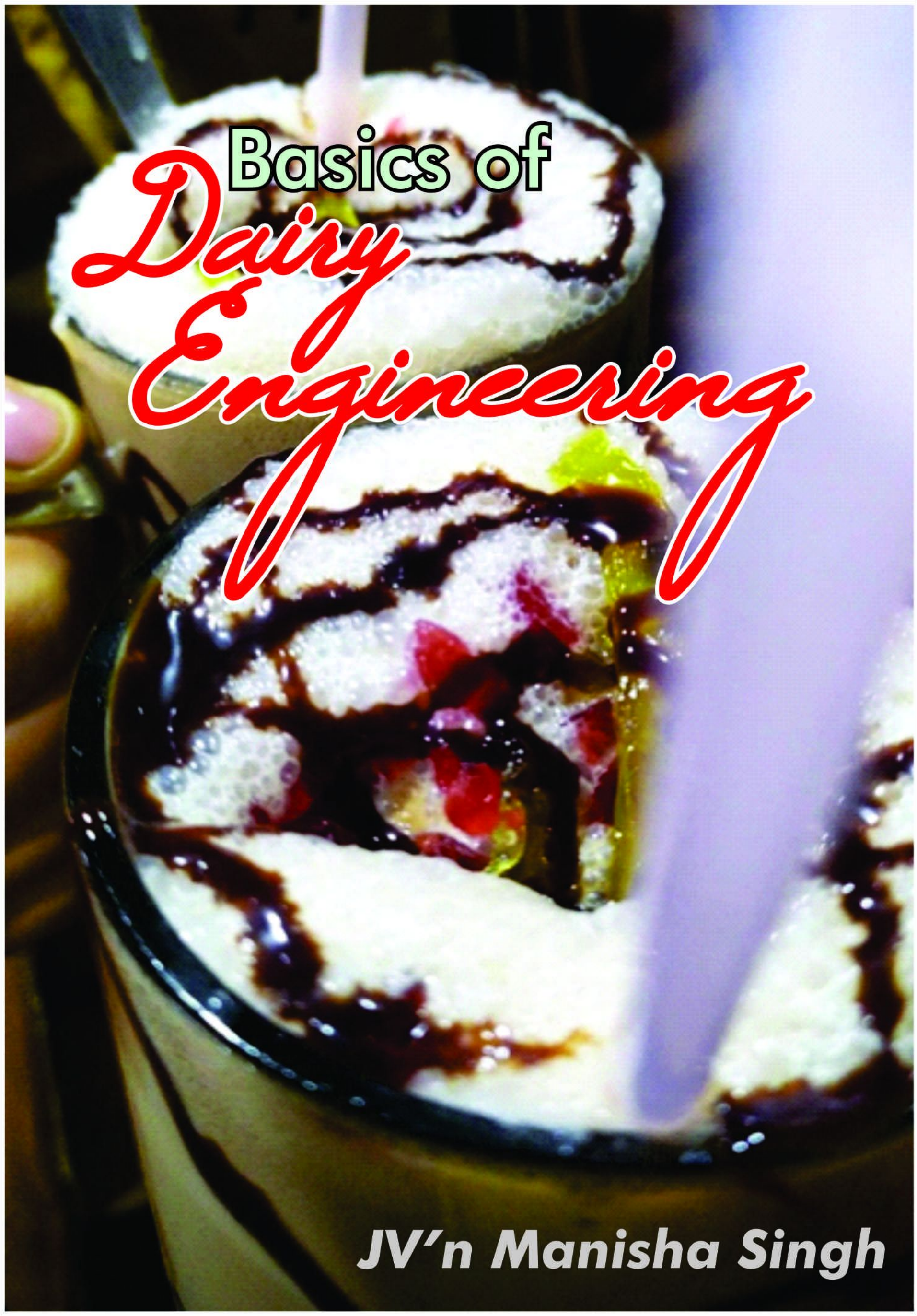
Women University Press
JPD
Jayoti Publication Desk
ISBN No. : 978-93-90892-46-4



Basics of Dairy Engineering

JV'n Manisha Singh

JAYOTI VIDYAPEETH WOMEN'S UNIVERSITY, JAIPUR

UGC Approved Under 2(f) & 12(b) | NAAC Accredited | Recognized by Statutory Councils

Printed by :
JAYOTI PUBLICATION DESK

Published by :
Women University Press
Jayoti Vidyapeeth Women's University, Jaipur

Faculty of Agriculture & Veterinary Science

Title: Basics of Dairy Engineering

Author Name Ms. Manisha Singh

Published By: Women University Press

Publisher's Address: Jayoti Vidyapeeth Women's University, Jaipur
Vedaant Gyan Valley,
Village-Jharna, Mahala Jobner Link Road, NH-8
Jaipur Ajmer Express Way,
Jaipur-303122, Rajasthan (INDIA)

Printer's Detail: Jayoti Publication Desk

Edition Detail: I

ISBN: 978-93-90892-46-4

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Chapter-I

Present Scenario of Dairying in India

Importance of milk and milk products in human nutrition

- Milk and milk products are highly nutritious and play a vital role for both children and adults in human diets. The composition of milk varies according to the animal from which it originates, assisting the young of that species with the required rate of growth and development. Therefore, human milk is better for human infants than milk for cows or any other milk product. For the first six months of an infant's life, exclusive breastfeeding without other foods or liquids is the optimal means of feeding. It is of great value to continue breast feeding for many more months, while the baby is introduced to other foods. In the second or even third year of life, if breast milk remains an important food for the child, then animal milk is not necessary in the child's diet.

- Casein and whey proteins are the most important components of cows' milk and are of high biological value. Disaccharide lactose is the carbohydrate in cows' milk. Fat is present as very fine globules, which appear to coalesce and rise to the surface as a cream layer upon standing. The fat has a rather high saturated fatty acid content. The calcium content (120 mg per 100 ml) of cow's milk is four times that of human milk (30 mg per 100 ml). If the human baby is fed entirely with cow's milk. The calcium in excess does not do any good, but does no harm.

- • Milk is also a very good source of riboflavin and vitamin A. It is a fair source of vitamin C and thiamine, but a poor source of niacin and iron. The mother usually gives her baby a supply of iron before birth. If milk feeding alone is prolonged after the sixth month, anaemia with iron deficiency can develop. All milk is rich in protein and other nutrients, despite the difference in the composition of milk from different animals, and constitutes a good diet for humans, particularly children. Although the majority of animal milk for human consumption comes from cows, the milk of buffaloes, goats, sheep and camels is significant in some societies.

- Milk is often eaten sour or curdled in many parts of the world than fresh since curdled milk holds longer, maintains its nutritional value, and may be more digestible and hygienic than fresh milk. However, drinking milk that has been boiled and stored in a clean container is much better, since milk can provide a vehicle for the transmission of certain species that cause disease.

- Milk pasteurisation significantly decreases the risk of transmitting pathological species if the milk is placed in clean containers intended for direct distribution to the customer.
- In many countries where cow's milk is a common dietary item, weaning infants from breastmilk to a diet in which cow's milk plays an important role is customary.
- Some individuals reduce their intake of milk because they suffer from lactose intolerance, a disease that results from low levels of the lactase digestive enzyme, a mono saccharide lactose spitting enzyme. Research indicates that most people who are lactose intolerant will still eat milk in moderate amounts without experiencing symptoms (perhaps three to five cups of milk a day).
- Two years ago, the NDDB established a National Dairy Plan to meet an expected demand of 180 million tonnes of milk by 2021-22. A two-pronged approach is proposed by this plan. First, by improving milk animals and optimum use of feed and fodder to fully realise the improved genetic capacity, doubling milk production over a 15-year period, and secondly, increasing the marketable surplus share of the organised industry, both cooperative and private dairies, from 30 percent to 65 percent.

Milk Utilization Pattern in India, 1943-2004	**Year**		
	1943*	**1956**	**2004**
Milk Production (million tonnes)	23.5	17.8	91
Milk Utilisation (Percentage)	100	100	100
Liquid Milk	28.0%	39.2%	46.0%
Traditional Products	72.0%	60.8%	50.0%
Ghee /Makhan (clarified butter)	58.7%	46.0%	33.0%

Dahi (Yogurt-like)	5.2%	8.8%	7.0%
Khova (Partially desiccated Milk)	5.0%	4.4%	7.0%
Channa and Paneer (unprocessed cottage cheese)	3.1%	1.6%	3.0%
Western Products: Milk Powder, etc	Neg	Neg	4.0%

- *Includes Pakistan and Bangladesh

  Source: Handbook on Technology of Indian Milk Products

Questions:

1. Explain the current status of dairy industry in India.
2. Explain the Importance of milk and milk products in human nutrition.

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Chapter – II

Milk- definition and its composition

Milk is the fluid secreted by the female from all mammalian species, mainly in order to fulfil the neonate's complete nutritional requirements, such as energy, essential amino acids and fatty acids, vitamins, minerals and water. Milk is a source of lipids, proteins (caseins and whey proteins), carbohydrates (mainly lactose), minerals (e.g. calcium and phosphate), enzymes, vitamins and trace elements that are efficient and balanced.

For more than 8500 years, milk from domesticated animals has provided humans with food. Milk contains a wide range of readily bio-available nutrients which, during the first stage of growth and development, allow this nutrient-dense product to be the sole food for neonates and infants. In addition, milk and dairy products provide a major contribution to the overall supply of adolescent and adult nutrients. The consumption of milk and milk products has been promoted by public health authorities since the early 1900s to improve the nutritional status of the population, especially children.

Over the past few decades, however, the reputation of milk and its products has been blemished, mainly because they contain saturated fatty acids that can increase serum cholesterol levels, which is known to be a risk factor for coronary heart disease. More recently, several studies have linked fat in general to the emerging obesity epidemic and to cancer. Recommendations from public health agencies to reduce the consumption of milk fat, however, mean that the diet is deprived of many bioactive components that can help avoid illnesses over a lifetime.

Milk (cow or buffalo or goat milk) may be defined as whole milk obtained by complete milking of one or more healthy milk animals, fresh, clean, lacteal secretion, except milk obtained within 15 days before or 5 days after calving or such periods as may be appropriate to make milk practically free of colostrum and containing the minimum prescribed percentages of non-fat milk fat and milk solids

Milk is a natural breast secretion resulting from the complete milking of a healthy milk animal without any addition or extraction thereof, unless otherwise legally justified and free of colostrum. Usually, the price of milk is dictated by its fat and/or SNF content. Milk plasma is classified as milk minus milk fat globules, which, although the separation of fat from the rest of the milk is never full, is similar in composition to skim milk (or separated milk). Milk serum, except for the presence of some proteolytic products of chymosin, is characterised as milk plasma minus casein micelles, which is similar to the whey composition.

Milk composition analysis, per 100 grams					
Constituents	**Unit**	**Cow**	**Goat**	**Sheep**	**Water buffalo**
Water	g	87.8	88.9	83.0	81.1
Protein	g	3.2	3.1	5.4	4.5
Fat	g	3.9	3.5	6.0	8.0
Saturated fatty acids	g	2.4	2.3	3.8	4.2
Monounsaturated fatty acids	g	1.1	0.8	1.5	1.7
Polyunsaturated fatty acids	g	0.1	0.1	0.3	0.2
Carbohydrate (i.e. the sugar form of lactose)	g	4.8	4.4	5.1	4.9
Cholesterol	mg	14	10	11	8
Calcium	mg	120	100	170	195
Energy	kcal	66	60	95	110
	kJ	275	253	396	463

Questions:

1. Explain the composition of the milk.

2. Define milk and explain the composition of milk.

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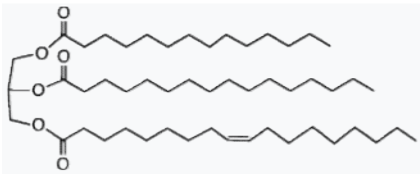
Thormar H, Isaacs EE, Kim KS, Brown HR: Interaction of visna virus and other enveloped viruses by free fatty acids and monoglycerides. Ann N Y Acad Sci 1994, 724:465-71. German JB: Butyric acid: a role in cancer prevention. Nutr Bull 1999, 24:293-9.

Chapter- III

Physio- chemical properties of milk



Butterfat is a triglyceride (fat) formed from myristic, palmitic, and oleic acid fatty acids.

Milk is an emulsion or colloid of butterfat globules containing dissolved mineral carbohydrates and protein aggregates inside a water-based fluid. Since it is created for young people as a food source, all of its material offers growth benefits. Nutrition (lipids, lactose and protein), biosynthesis of protein-supplied non-essential amino acids (essential amino acids and amino groups), essential fatty acids, vitamins and inorganic components, and water are the main requirements.

pH

The milk pH ranges from 6.4 to 6.8, and over time it varies. In composition, milk from other bovines and non-bovine mammals differs, but has a similar pH.

About lipids

Milk fat is initially secreted in the form of a fat globule that is enclosed by a membrane. Each fat globule consists almost entirely of triacylglycerols and is surrounded by a membrane consisting of, along with proteins, complex lipids such as phospholipids. These serve as emulsifiers that prevent the individual globules from coalescing and protect the contents of these globules in the fluid portion of the milk from different enzymes. While triacylglycerols make up 97-98% of lipids, there are also small amounts of di- and monoacylglycerols, free cholesterol and cholesterol esters, free fatty acids, and phospholipids. Fat content in milk differs greatly in composition, unlike protein and carbohydrates, due to genetic, lactational, and nutritional factor variations between different organisms.

Like composition, the size of fat globules varies between different species from less than 0.2 to around 15 micrometres in diameter. The diameter may also vary between animals within a species and at various times within a single animal's milking process. The fat globules have an average diameter of two to four micrometres in unhomogenized cow's milk, and with homogenization, an average of about 0.4 micrometres. Within the milk fat component of the milk, the fat-soluble vitamins A, D, E, and K along with essential fatty acids such as linoleic and linolenic acid are included.

The Proteins

There are 30-35 grammes of protein per litre of normal bovine milk, of which about 80 percent is arranged in casein micelles. In milk, total proteins account for 3.2 percent of its composition (nutrition table).

Caseins Caseins

'Casein micelles' are the largest structures in the fluid portion of the milk: aggregates of several thousand protein molecules superficially resembling surfactant micelles, bound with the aid of nanometer-scale calcium phosphate particles. Each casein micelle is around one tenth of a micrometre across and approximately spherical. Four different forms of casein proteins are available: alpha1-, alpha2-, beta- and alpha-caseins. Most of the casein proteins in the micelles are bound. Concerning the exact composition of the micelles, there are several conflicting hypotheses, but they share one significant feature: the outermost layer consists of strands of one type of protein, k-casein, extending into the surrounding fluid from the micelle's body. These kappa-casein molecules all have a negative electrical charge and thus repel each other, keeping the micelles in the water-based surrounding fluid isolated under normal conditions and in a stable colloidal suspension.

Apart from caseins and enzymes, milk comprises hundreds of other types of proteins. These other proteins are more water-soluble and do not form bigger structures than caseins. When caseins coagulate into curds, since the proteins remain suspended in whey, they are collectively known as whey proteins. By a substantial margin, lactoglobulin is the most common whey protein. The ratio of caseins to whey proteins varies greatly between species; in cows, for instance, it is 82:18 and in humans, it is about 32:68.

Ratio of caseins to whey proteins in milk of nine mammals	
Species	**Ratio**
Human	29.7:70.3 – 33.7:66.3
Bovine	82:18
Caprine	78:22
Ovine	76:24
Buffalo	82:18
Equine	52:48
Camel	73:27 – 76:24
Yak	82:18
Reindeer	80:20 – 83:17

Salts, minerals, and vitamins

Common names for a number of cations and anions within bovine milk are minerals or milk salts. All minerals contain calcium, phosphate, magnesium, sodium, potassium, citrate, and chloride, which usually occur at a concentration of 5-40 mM. Milk salts interact strongly with casein, most specifically with calcium phosphate. It is present in excess of solid calcium phosphate solubility, and also in even greater excess. Milk is a good source of many other vitamins, besides calcium. Milk contains vitamins A, B6, B12, C, D, K, E, thiamine, niacin, biotin, riboflavin, folate, and pantothenic acid.

Structure of calcium phosphate

The most accepted theory of a micelle's structure for many years was that it consisted of spherical casein aggregates, called submicelles, that were kept together by linkages of calcium phosphate. There are, however, two recent casein micelle models that refute the distinct micellular structures within the micelle.

The first theory attributed to de Kruif and Holt indicates that calcium phosphate nanoclusters and beta-casein phosphopeptide fraction are the centrepiece of the micellular structure. Specifically, unstructured proteins organise around calcium phosphate in this view, giving rise to their structure and therefore no specific structure is formed.

The growth of calcium phosphate nanoclusters starts the process of micelle formation, but is restricted by binding phosphopeptide loop areas of the caseins, the second theory suggested by Horne. When bound, protein-protein interactions are formed, and polymerization occurs to form micelles with trapped calcium phosphate nanoclusters in which K-casein is used as an end cap.

Some reports suggest that the trapped calcium phosphate is in the form of $Ca9(PO4)6$, while others say that it is identical to the mineral brushite structure of $CaHPO4-2H2O$.

Carbohydrates and Sugars

A simplified representation of the breakdown of a lactose molecule into glucose (2) and galactose (1)

Like lactose, glucose, galactose, and other oligosaccharides, milk contains several distinct carbohydrates. The lactose gives milk its sweet taste and adds about 40 percent of the calories of the whole cow's milk. Lactose is a composite disaccharide of glucose and galactose, two basic sugars. An average of 4.8 percent anhydrous lactose is bovine milk, which amounts to about 50 percent of the total skimmed milk solids. Lactose levels depend on the form of milk, because other carbohydrates can be found in milk at higher concentrations than lactose.

Different Contents

Living white blood cells, mammary gland cells, numerous bacteria, and a large number of active enzymes are additional components present in raw cow's milk.

Appearancing

The opaque white colour of milk refers to both the fat globules and the smaller casein micelles, which are only wide enough to deflect light. The fat globules produce some yellow-orange carotene, enough to add a golden or "creamy" hue to a glass of milk in some breeds (such as Guernsey and Jersey cattle). Riboflavin has a greenish tint in the whey component of milk that can often be discerned in skimmed milk or whey products. In order to spread light, fat-free skimmed milk only has casein micelles, and they appear to disperse shorter-wavelength blue light rather than red, giving a bluish tint to skimmed milk.

Questions:

1. Explain the physicochemical properties of food.

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Chapter- IV

Milk reception and storage

Introduction

In maintaining its consistency, the handling of milk within the plant is the key factor. Milk is graded for acceptance/expulsion upon arrival, measured, sampled for testing, cooled and processed under refrigeration before operation of the next unit for preliminary processing in the dairy plant is completed.

MILK

Milk can be shipped in cans or tankers to the milk factory (road or rail). In order to provide a continuous supply of milk to the pasteurizer, milk obtained in these systems must be sampled, graded, vacuumed, measured (weight or volume) and bulked.

The cans are manually off-loaded to the tipping point in the absence of mechanical assistance, where the lids/covers are removed and the milk examined. They are then manually tipped and, via a 'Drip saver' or 'Drain rack', all cans and lids move on to a can-washer. The process is mechanised and the cans are unloaded directly from the truck onto the conveyor (power-driven or by gravity roller) when a higher throughput is necessary, and the tipping, sampling and weight recording can be fully automated.

The milk in the weighing tank/pan is tipped. Such a weighing tank is suspended from a weighing machine with the weight reflected on the dial. For rapid receipt, two weighing tanks can be used. To permit rapid emptying, the discharge valve has a large diameter. The milk is discharged directly under the weighing pan into a 'dump tank'. Milk can be continuously pumped from here to a raw milk storage tank, usually placed at a height to allow gravity to flow to the pasteurising facility.

It is mainly a matter of having a covered area under which emptying and subsequent cleaning may take place for the receiving of milk from large rail or road tankers. Sanitary piping must be attached to the tanker outlet. A milk pump mounted at a level lower than the tanker may extract the milk, or a compressed air line may be attached to the top of the tanker and pneumatic pressure may push the milk out. Immediately after emptying is complete, cleaning and sanitization of the tanker should follow. A weighing bridge or flow-meter is used to assess the milk supplied by tankers.

It has already been graded, measured, sampled and cooled if milk is obtained from chilling centres. It may again be weighed and sampled, or the report of the centre may be used. The latter method applies in particular to deliveries by tankers.

To avoid delays in processing, milk receipt should be performed in a scheduled manner. If the milk is collected continuously during the planned time, activities in the plant will not be disrupted and employees will be completely engaged in the different parts. The objective should be to complete the receipt of milk within 3-4 hours, especially in tropical countries. Processing delays can lead to degradation of the milk awaiting dumping, increase labour costs and can increase the can-operating washer's costs. Market milk needs premium-quality milk (from the standpoint of aesthetic quality, health, flavor, sanitation, keeping quality). The consistency of the incoming milk significantly affects the quality of the milk extracted (or manufactured products). It is well known that the RMRD's sanitary quality of milk depends on its farm history, i.e. Good animals, the processing of clean milk, clean utensils, prompt cooling and refrigerated transportation. There is, however, a need for systematic and detailed inspection by diligent and experienced milk graders of all milk supplies each day.

It should be at 5 ° C or below when milk is obtained at the dairy plant. The milk should be clean, soft, nicely flavoured, free of off-flavors and relatively free of foreign materials, such as antibiotics, pesticides and other chemicals or metals. There should not be approval of irregular milk. Also from a heat stability standpoint, acid production is objectionable.

Operations at Milk Reception

Unloading, measuring, sampling, grading and checking can be subdivided into the method of obtaining milk.

1. Unloading

Besides the unloading table, the truck holding the loaded cans is transported. Then, the milk cans are manually unloaded. The milk cans are then assembled for grading in a definite order, according to each supplier, viz. The builder or patron. If a milk tanker is used, it is first properly placed so that in the Tanker Bay pipe fitting connections can be made easily.

2. Grading

It is well known that the finished product's quality depends on that of the raw material used. This refers to the classification of milk for price-fixation, on the basis of its consistency. The milk grader is the key person for correct milk selection. The theory of grading is based on organoleptic (sensory) tests such as those for appearance, smell (odour), and taste, acidity sediment etc. are included under platform tests.

Note - In order to decide on its acceptance/rejection, the term 'Platform Tests' requires all tests carried out to verify the consistency of the incoming milk. They are carried out with the objective of detecting milk of poor or questionable quality on each can/tanker of milk, preventing it from being mixed with high-grade milk.

The milk grading technique is as follows:

2.1 Milk (road/rail) tanker

At the milk collection-cum-chilling centre, the grading has already been completed. It is not possible to detect off-odors because milk is chilled (< 5°C). The presence is noted, as raw milk testing is normally avoided. A sample is taken for laboratory processing after thoroughly mixing it for 5-10 min.

2.2 Milk is capable of

Appearance, smell and temperature (touch) are the key measures applied to each can of milk; other tests, such as taste (rarely carried out with raw milk) and sediment, may be used to substantiate the initial findings. The quality control technician conducts tests requiring time, laboratory equipment, and special techniques for which a sufficiently large sample is taken.

3. Platform tests

3.1 Appearance

For any floating extraneous matter, off-color, or partially churned milk, observe each can of milk. The colour of the milk should be natural, free of churned fat globules and relatively free of any floating foreign matter.

3.2 Scent The Smell (Odour)

This gives an outstanding indicator of the organoleptic content of milk that can be easily calculated (in seconds). The cover of each can is removed, rotated, and lifted to the nose when the test is carried out. You can smell the headspace in the milk. The test can be repeated by removing the lid and shaking the can vigorously. The acceptance/rejection of the milk is determined by an experienced milk grader with a "trained nose." Milk should be free from any flavours that are off.

Temperature of 3.3

The temperature at which milk is supplied is also a sign of its consistency. A regular milk temperature check is helpful in ensuring that milk quality is tested. With practise, by touching the side of the can, the grader will tell with a high degree of accuracy if the milk is sufficiently cold. There is a satisfactory temperature of 5°C or below.

Sediment 3.4 The sediment

The noticeable foreign matter present in the milk is shown by the sediment examination. It does not need to be performed on a regular basis, but it should be carried out often. A reliable sediment tester (such as an off-the-bottom sediment tester) is used for this purpose. It should be considered satisfactory for any process by which full sediment is collected. A low sediment requirement is desirable. To assess the cleanliness of milk, sediment testing is performed. There is no link between sediment quantity and milk's bacteriological quality. The amount of milk weighed is filtered or centrifuged and tested for sediment. There is no visible dirt in good quality milk, while low quality milk displays dark or blackish stains on the filter pad. Based on BIS criteria, the milk is assessed for its consistency.

Acidity 3.5

It is beneficial to have 'normal' or 'apparent' milk acidity that does not adversely affect its heat stability. Nevertheless,' developed acidity' (Natural + Developed = Titratable acidity) has a negative effect on the consistency of milk that can not be processed in a pasteurizer.

3.6 Reading Lactometer

The addition of water to milk results in its density being decreased. This test is therefore used for the identification of milk adulteration with water. When assessed at 15.5 °C, the reading for cow and buffalo milk should be around 28 to 30 and 30 to 32 respectively.

4. Sampling, sampling

It is difficult to over-emphasize the importance of securing a reliable and representative milk sample for chemical and bacteriological analysis. Although strict precautions are needed for the sterility of the stirrer, sampler, jar, etc. to obtain a bacteriological sample, the dryness and cleanliness of the above equipment for a chemical sample should be appropriate. Thorough mixing of milk is the first pre-requisite for sampling. This can be achieved by manually or mechanically operating a plunger or stirrer (agitator) for milk stored in cans or tankers, as the case may be. For the former, after pouring the milk in the weighing tank, a representative sample can be taken, whereby it is mixed in so thoroughly that a representative sample can be taken without further mixing.

Samples can include: individual, composite (mixture of two or more individual milk lots), drip (representing the supply of the entire day), etc. Dipper-tube or proportionate (also known as milk thief), automatic vacuum, drip, etc. can be samplers.
The sample of composite milk must not be spoiled by the time it is tested. This is done by the use of a preservative. Until milk is added, it is prudent to put the preservative in an empty bottle. For holding composite samples of milk or cream, a big mouthed glass bottle with a rubber stopper is suited. The commonly used preservatives are as follows:

4.1 Mercuric chloride or sublimate corrosive

It's really poisonous here. In order to prevent milk from being mistaken for food consumption, it can be added in the form of tablets that are coloured (usually bright red).

4.2 Formalin

This is a 40 percent formaldehyde solution. It is really easy to treat since it is liquid. It interferes with the fat test, however.

4.3 Dichromate potassium

This is not as powerful as the two above, but since it is available in tablet form, it is simple to manage in dairy plants.

Remember - The composite samples should be kept away from direct sunlight in a cool spot. Each bottle should be labelled properly.

5. Weighing
In accounting for milk receipts, disposal and making payments for milk, this is an important step. Milk from cans, either manually or mechanically, is poured into the weighing tank. The tank is placed on a scale and when the tank is empty, the scale dial is set at zero. Automatic weight printing is now becoming a procedure.

By going through a flow metre, the milk in tankers (road or rail) can be measured by volume and its calculation can be converted into weight by multiplying volume by density ($m = d * v$).
In the case of bridge-weighing road milk tankers, the weight can be estimated (tanker weight when full-weight when empty).

6. Checking with

Prior to its acceptance for processing, further testing is needed in the case of 'doubtful quality'. The necessary tests are conducted by the Quality Control Laboratory of the milk plant. For making payments and for ISO reports, a record of the chemical and bacteriological content of all approved milk has to be kept.

7. Milk storage:

Raw milk is pumped through a filter and chiller from the dump tank to the storage tank. The aim of the storage tank is to keep milk at low temperatures in order to maintain consistency in the operation of milk processing and to avoid any quality degradation during the holding and processing time.

The milk can arrive in cans at a chilling centre or milk plant. Milk is chilled and stored in storage tanks after unloading the cans. In order to store raw or even pasteurised milk, storage tanks are used. Milk can be stored in the tank in a chilled state ($< 5\ °C$) for up to 72 hours between receipt and processing. The milk storage capacity should usually be equal to a day's intake.

Storage Tanks Goals

To maintain milk at a low temperature in order to avoid any quality degradation prior to processing/product production.
To promote the supply of raw milk by bulking, ensuring a uniform composition
To allow uninterrupted functioning during processing and packaging
Enabling the standardisation of milk

Tank of Energy

Storage tanks allow the storage of milk for longer holding periods. They must be planned, preferably through the CIP process, for easy cleaning and sanitization. Storage tanks consist of an inner shell of stainless steel, an insulation sheet, an outer jacket and essential fittings for inspection and cleaning control. The tanks should be insulated or refrigerated so that during the holding time they can maintain the necessary temperature. For insulation, glass wool, thermocolum, corkboard, foam glass or styrofoam may be used. In the lower portions of the tank, corkboard or foam glass is used where the insulation can hold a part of the load. Agitation must be sufficient for homogeneous mixing, but gentle enough to avoid churning and incorporation of air. In several storage tanks, to maintain the milk temperature, a chilled water circulation system is provided. In order to allow access to the interior for cleaning and inspection, all closed tank types must be fitted with a manhole round (diameter ~ 450 mm) or oval-shaped.

A curved filling pipe is used for foam-free entry of milk, which directs the milk toward the wall. It is safer to fill the tank with the lowest outlet tubing, i.e., from below. On the first level, storage tanks containing raw chilled milk or uniform pasteurised milk are typically located. This allows pasteurizers or even gravity filling of milk to be fed to the milk. Large-sized silos, typically with a capacity of > 1.0 lakh litres, are now mounted in dairies on the ground floor only. They are very helpful for feeding the powder plants in the storage of skim milk. In the milk industry, rectangular tanks are less common than cylindrical tanks, because it is difficult to clean sharp corners (in rectangular ones). Secondly, extreme corners of rectangular tanks are not reached by the agitation effect.

Storage Tank Types

On the basis of their form and other characteristics, storage tanks may be categorised.

1. Tanks for insulated storage

The milk is simply stored at the temperature at which it is filled in these tanks. In certain cases, there is a tendency to raise the temperature of long-storage milk, depending on the consistency of the insulating content. These tanks consist of an inner shell made of stainless steel, an insulation layer (thermocol and glass wool) and an outer jacket made of stainless steel or mild steel.

2. Tanks that are refrigerated

It has refrigerating facilities built-in so that stored milk is chilled as and when needed. In these tanks, this extra feature of preserving the optimal temperature is an added benefit. The hollow space between the inner and outer shells is used for circulating the cooling medium in refrigerated tanks (chilled water or brine solution).

3. Tanks that are horizontal or vertical

Horizontal tanks need more floor space, but need less headspace than vertical ones. Horizontal tanks (5,000 to 15,000 litres of capacity) can be used for handling small volumes. Milk is now stored in vertical storage tanks of one lakh litre capacity or more, usually referred to as silos, every day. Installed outside the house, these are vertical cylindrical tanks. In these silos, milk feed is mounted near the bottom of the same discharge valve.

FAQ: Questions:
1. What are the milk retrieval steps?
2. Explain the milk Platform Tests.
3. Explain in depth the handling of milk.

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Chapter-V

Pasteurization

Pasteurization, Method for heat treatment that kills pathogenic microorganisms in some foods and drinks. It is named for the French scientist Louis Pasteur, who showed in the 1860s that abnormal fermentation of wine and beer could be prevented for a few minutes by heating the drinks to around 57 ° C (135 ° F). Widely practised in many countries, especially the United States, pasteurisation of milk includes temperatures of about 63 ° C (145 ° F) sustained for 30 minutes or, instead, heating to a higher temperature, 72 ° C (162 ° F) and holding for 15 seconds (and yet higher temperatures for shorter periods of time). The times and temperatures are those that are determined to be sufficient for the destruction of the non-spore-forming, disease-causing microorganisms found in milk, Mycobacterium tuberculosis and other more heat-resistant. Most of the microorganisms that cause spoilage are also killed by the treatment and hence the food storage period is extended.

Phase of pasteurisation

General description of the method of pasteurisation. The milk begins on the left and enters the tube with working enzymes that are denatured and stop the enzymes from functioning when heat-treated. This helps stop the growth of the pathogen by preventing the cell's functioning. The cooling process helps prevent the Maillard reaction and caramelization from going through the milk. The process of pasteurisation also has the ability to heat the cells to the point that they burst from the build-up of pressure.

Pasteurization is a mild heat treatment (both packed and unpackaged) of liquid foods in which items are usually heated to below 100 °C. The heat treatment and cooling process is designed to prevent the product's phase shift. The parameters (time and temperature) of heat treatment and the length of shelf life are determined by the acidity of the food. Parameters also take heat sensitive nutritional and sensory qualities into account.

Heat treatments are intended to inactivate enzymes (pectin methylesterase and polygalacturonase in fruit juices) in acidic foods (pH <4.6), such as fruit juice and beer, and to eliminate spoilage microbes (yeast and lactobacillus). Pathogens are unable to expand due to the low pH of acidic foods. Thus, the shelf-life is extended by several weeks. Heat treatments are intended to kill bacteria and ruin species in less acidic foods (pH >4.6), such as milk and liquid eggs (yeast and molds). Under pasteurisation parameters, not all spoilage species are killed, so subsequent refrigeration is required.

Facilities

It is possible to pasteurise food in two ways: either before or after packing it into containers. Hot water is used when food is wrapped in glass to lower the risk of thermal shock. For food packaging, plastics and metals are often used, and these are normally pasteurised with steam or hot water as the thermal shock risk is minimal.

Most liquid foods are pasteurised by means of continuous systems with a heating zone, a holding tube, and a cooling zone after which the product is packed. For products with low viscosity, such as animal milk, nut milk and juices, plate heat exchangers are used. Many thin vertical stainless-steel plates separating the liquid from the heating or cooling medium are composed of a plate heat exchanger. Scraped surface heat exchangers have an inner rotating shaft in the tube, which serve to scrape highly viscous material which might collect on the wall of the tube.

For pasteurisation of non-Newtonian foods such as dairy products, tomato ketchup and baby foods, shell or tube heat exchangers are intended. Concentric stainless-steel tubes are made up of a tube heat exchanger. When the heating/cooling medium is pumped through the outer or inner tube, food passes through the inner tube.

The advantages of pasteurising non-packaged foods using a heat exchanger over pasteurising foods in containers are:

Heat exchangers have standardised care, and the items that can be pasteurised on these plates are more versatile.

Compared with pasteurising foods in packaged containers, the process is more energy efficient.

• Better production

The substance flows through a hold tube for a fixed period of time to obtain the necessary treatment after being heated in a heat exchanger. A flow diversion valve is used to redirect under-processed product back to the raw product tank if pasteurisation temperature or time is not reached. It is cooled in a heat exchanger if the product is properly treated, then filled.

High-temperature short-time (HTST) pasteurisation, such as that used for milk (71.5 °C (160.7 °F) for 15 seconds) guarantees protection of milk and offers a refrigerated shelf life of approximately two weeks. Milk is pasteurised at 135 °C (275 °F) for 1-2 seconds during ultra-high-temperature (UHT) pasteurisation, which offers the same degree of protection but, along with the packaging, increases shelf life under refrigeration to three months.

Verification, verification

Direct microbiological methods are the ultimate measurement of pathogen contamination, but they are expensive and time-consuming, ensuring that by the time pasteurisation is checked, products have a shortened shelf-life.

The effectiveness of milk pasteurisation is usually controlled by testing for the existence of alkaline phosphatase denatured by pasteurisation as a consequence of the inadequacy of microbiological techniques. Alkaline phosphatase degradation guarantees the destruction of common milk pathogens. Therefore, an ideal measure of pasteurisation efficacy is the presence of alkaline phosphatase. The efficacy of heat treatment is assessed in the case of liquid eggs by the residual activity of alpha-amylase.

Efficacy against bacteria that are pathogenic

There was no robust awareness of what time and temperature combinations would inactivate pathogenic bacteria in milk during the early 20th century, and so a variety of distinct standards of pasteurisation were in use. By 1943, for a variety of pathogenic bacteria in milk, both HTST pasteurisation conditions of 72 °C (162 °F) for 15 seconds and batch pasteurisation conditions of 63 °C (145 °F) for 30 minutes were verified by studies of total thermal death (as best as could be measured at that time). Subsequently, complete inactivation of Coxiella burnetii (which at that time was thought to induce Q fever through oral ingestion of contaminated milk) and Mycobacterium tuberculosis (which causes tuberculosis) was shown. These conditions were sufficient for all practical purposes to kill almost all yeasts, moulds and common spoilage bacteria and also to ensure adequate destruction of common pathogenic, heat-resistant species. The microbiological techniques used until the 1960s, however, did not allow the actual bacterial reduction to be enumerated. A analysis of surviving bacteria in milk that was heat-treated after being intentionally spiked with high levels of the most heat-resistant strains of the most important milk-borne pathogens has demonstrated the degree of the inactivation of pathogenic bacteria by milk pasteurisation.

The mean reduction in log10 and the inactivation temperature of the main milk-borne pathogens during 15 seconds of treatment are as follows:

Staphylococcus aureus> 6.7 at 66.5 °C (151.7 °F)

- *Yersinia enterocolitica*> 6.8 at 62.5 °C (144.5 °F)
- pathogenic *Escherichia coli*> 6.8 at 65 °C (149 °F)
- *Cronobacter sakazakii*> 6.7 at 67.5 °C (153.5 °F)
- *Listeria monocytogenes*> 6.9 at 65.5 °C (149.9 °F)
- Salmonella ser. Typhimurium > 6.9 at 61.5 °C (142.7 °F)

(A $\log_{10}$ reduction between 6 and 7 means that 1 bacterium out of 1 million (10^6) to 10 million (10^7) bacteria survive the treatment.)

The Codex Alimentarius Code of Hygienic Practice for Milk states that pasteurisation of milk is intended to achieve a reduction of Coxiella burnetii of at least 5 log10. "The Code also notes that: "Minimum pasteurisation conditions are those with bactericidal effects equal to heating each milk particle to 72 °C for 15 seconds (continuous flow pasteurisation) or 63 °C for 30 minutes (batch pasteurisation)" and that "The milk flow in heat exchangers should be turbulent to ensure that each particle is sufficiently heated, i.e. Reynolds number shooting

Modern HTST pasteurisation processes must be equipped with flow rate limitation as well as divert valves as a precaution to ensure that the milk is heated uniformly and that no portion of the milk is subjected to shorter or lower temperatures. It is normal for temperatures of 1.5 °C or 2 °C to reach 72 °C.

Effects on the nutritional and sensory features of pasteurised foods

Pasteurization extends the shelf-life by a few days or weeks due to its moderate heat treatment. This mild heat, however, also ensures that only small improvements are made to the heat-labile vitamins in foods.

MILK

According to a systematic review and meta-analysis, it was found that pasteurisation seemed to decrease vitamin B12 and E concentrations, but it also increased vitamin A concentrations. In addition to the meta-analysis, conclusions on the impact of pasteurisation on vitamins A, B12 and E cannot be drawn based solely on the consultation of the vast literature available. In the North American diet, milk is not an essential source of B12 or E vitamins, so the effects of pasteurisation on the daily consumption of these vitamins by adults are negligible. Milk is, however, considered an essential source of vitamin A, and the effect of milk heat treatment on this vitamin is not a major public health issue, as pasteurisation tends to increase vitamin A concentrations in milk. Meta-analysis findings indicate that milk pasteurisation results in a substantial decrease in vitamin C and folate, but milk is not an essential source of these vitamins either. After pasteurisation, a substantial decrease in vitamin B2 concentrations was observed. In bovine milk, vitamin B2 is usually present at concentrations of 1.83 mg/liter. Since the recommended daily dose for adults is 1.1 mg/day, the recommended daily intake of this vitamin contributes significantly to milk consumption. Pasteurization does not seem to be a problem in decreasing the nutritional value of milk, with the exception of B2, since milk is also not a primary source of these vitamins studied in the North American diet.

Sensory influences

There is also a slight but observable effect of pasteurisation on the sensory properties of the processed foods. Pasteurization can result in the loss of volatile aromatic compounds in fruit juices. Until pasteurisation, fruit juice products undergo a phase of deaeration that may be responsible for this failure. Deaeration also minimises the loss of nutrients such as carotene and vitamin C. Volatile recovery, while expensive, can be used to manufacture higher-quality juice products to avoid the drop in quality resulting from the loss of volatile compounds.

With regard to colour, pigments such as chlorophylls, anthocyanins and carotenoids in plants and animal tissues do not have much effect on the pasteurisation process. The major enzyme responsible for causing browning and colour changes is polyphenol oxidase (PPO) in fruit juices. This enzyme, however, is deactivated with oxygen removal in the deaeration step prior to pasteurisation.

In milk, the difference in colour between pasteurised and raw milk is connected to the process of homogenization that takes place before pasteurisation. Milk is homogenised prior to pasteurisation to remove the solids (fat) from the liquid, resulting in a whiter appearance of the pasteurised milk compared to raw milk. Color degradation for vegetable products depends on the temperature conditions and the length of the heating process.

As a result of enzymatic and non-enzymatic changes in the structure of pectin, pasteurisation can result in some texture loss if the processing temperatures are too high as a result. However, with mild heat treatment pasteurisation, tissue softening in the vegetables that causes textural loss is not of concern as long as the temperature does not get above 80 °C (176 °F).

Novel methods of pasteurisation

In order to minimise the impact on nutritional and sensory characteristics of foods and to avoid degradation of heat-labile nutrients, other thermal and non-thermal methods have been developed to pasteurise foods. Examples of these non-thermal pasteurisation methods that are commonly used commercially are pascalization or high pressure processing (HPP) and pulsed electric field (PEF).

Microwave volumetric heating (MVH) is the newest pasteurisation technology that is available. It heats liquids, suspensions, or semi-solids in a continuous flow using microwaves. Because MVH delivers energy evenly and deeply into the whole body of a flowing product, it allows for warming to be smoother and shorter, thus preserving almost all heat-sensitive substances in the milk.

A patented method that involves spraying droplets in a chamber heated below the usual pasteurisation temperatures is Low Temperature, Short Time (LTST). The treatment of liquid products takes several thousandths of a second, so the method is also known as the millisecond technology (MST). When combined with HTST, it significantly extends the shelf life of products (50+ days) without harming the nutrients or flavour. Since 2019, LTST has been commercial.

FAQ: Questions:

1. Explain the procedure for milk pasteurisation.

2. Explain pasteurisation efficacy for pathogenic bacteria.

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Chapter VI

Sterilisation

Sterilisation

Definition

Sterilized milk refers to a product obtained in a commercial cooker/retort container by heating milk to temperatures of 110-130OC for 10-30 min. The mechanism is also known as in-container sterilisation. In general, sterilised milk is intended for extended storage at room temperature (up to 6 months). Microbial and enzymatic activity is destroyed by the main goal of heat sterilisation. Depending on the type of product, the number and heat tolerance of microorganisms and enzymes present in milk, the length of time and magnitude of temperature used during processing. Microorganisms or enzymes are typically tested for heat tolerance in terms of D-value or Z-value. In terms of Fo value, sterilisation load or heat load for sterilisation is usually expressed.

Theoretical basis

The index organism for the evaluation of thermal sterility in foods is called Clostridium botulinum. Under anaerobic conditions, it can develop botulin, a toxin that can be 65 percent lethal to humans, within a sealed jar. The destruction of this organism is therefore the minimum requirement for the sterilisation of heat. Since milk is a low acid (pH>4.5) product, C.botulinum is recommended to achieve 12 decimal reductions. This can be accomplished by heating the product for 3 min(Fo = 3) at 121OC. This minimum therapy can, however, generate milk that is healthy but not generally commercially sterile. This is because there are more spores found in milk that are heat-resistant. B is there. B or stearothermophilus. Sporothermodurans. These are not pathogenic to the spores. Heat treatment equal to two (2) or more decimal reductions can require their presence. This could be equivalent to an F0 value of 8. In every 10,000 containers, goal spoilage levels should be less than one survivor.

Types of Plants for Sterilization

In service, sterilising retorts are either batch form or continuous. Sterilizers of the batch type can be either vertical or horizontal. It is easier to load or unload horizontal retorts. They have facilities for container/cage agitation. They need more floor space, however. These horizontal retorts usually have concentric cages. Cans are placed into the annular space between the cages horizontally. The retort is locked when the cages are complete. Guide rails protect the cages, slowly turning them. This stirring of the contents in the cans makes it easier to heat properly. Generally, continuous retorts are fitted with stronger controls. Within the cans, they trigger very subtle changes in pressure. Products are thus heated more evenly. In contrast to the batch process, seams may also be subject to less pressure.

There are primarily three types of continuous sterilisers: (a) cooker-coolers; (b) hydrostatic sterilisers; and (c) rotary sterilisers. Cooker-coolers hold cans that travel through three sections of a tunnel on a conveyor. These parts are maintained for preheating, sterilisation and cooling at various pressures. The hydrostatic steriliser consists of a chamber fitted with steam injection provisioning. Two water columns (12 to 18 metres high, barometric leg) which are used to change pressure in the chamber are connected to the chamber that is partially full of water. If the height of the water columns is increased, the vapour pressure will change and the maximum temperature attainable will also change. For instance, a difference in height between the two water columns should be 10.7 m to get a temperature of 116oC, while the water column difference should be 13.7 m to achieve a temperature of 121oC in the chamber. A conveyor travels through the steam chamber carrying the food cans with arrangements for accommodating cans of various sizes. By changing the speed of the conveyor, the heating time could be controlled. For large-capacity plants, hydrostatic sterilisers are very versatile and suitable. However, the main drawbacks of this system are the scale of the structure and the high cost of capital.

The continuous rotary steriliser consists of several interlinked horizontal cylinders that allow up to four continuous stages of preheating, heating, precooling and cooling. The vessel has a spiral track on the inner wall. Inside the cooker's centre, a spoke or reel allows the cans to roll along the spiral track. Rotary valves are used to interconnect the shells, maintain heating pressure and cooling parts. Straight from the sealing machines, sealed cans are introduced. As cans move along the helix, the contents inside the cans are mixed, thus enhancing heat transfer and ensuring less heat damage to the product. Cans that come from the cooker are brought directly to the machine for marking and palletizing. Rotary sterilisers are especially suitable for the processing of products based on milk and milk that are highly sensitive to heat and are prone to browning.

The Canning Process Overview

Basic operations in the traditional retorting/canning process include: raw material preparation, container filling, exhausting, can sealing, sterilisation, can cooling, labelling and storage. Raw material preparation refers to washing, peeling, cutting, blanching, pre-cooking, etc. in the case of fruits, vegetables, meat, etc.; and preheating, mixing, homogenization, e.g. Tank filling can be done either manually or mechanically. Right and accurate filling is necessary both from an economic point of view and to prevent large amounts of air/ gas from being trapped within the can, which could reduce the intensity of heat treatment. In the canning process, exhausting is a necessary procedure and requires removal of air/oxygen from the container until it is closed. Air removal ensures minimal pressure on the seams of the can or pouch seals during heat processing by expanding the air. Oxygen removal is necessary through oxidation and vacuum formation within the container during cooling to avoid internal corrosion of the container. In addition to destroying ascorbic acid, the absence of oxygen within the container often delays the oxidative degradation of the substance.

Containers are sealed until exhaustion. Sealing machines are selected based on the type of container (metal cans, glass bottles, flexible pouches). While tins are closed with a double seal on the seal side and may also be vacuum-sealed, glass jars are typically vacuum-sealed. By combining two thermoplastic materials, flexible retortable pouches are sealed by applying heat through heated plates or jaws.

In an atmosphere of saturated steam or hot water or air-steam mixture, the product in the closed containers is heated in a steriliser. Steam's sterilising operation relies on the latent vaporisation heat as it condenses on the can's surface. Saturated steam condenses quickly and is thus an effective sterilising medium. A very important step is the expulsion of all air present in the retort by steam before the steriliser is brought to operating temperature. This is also referred to as venting. The aim of this processing step is to preserve the sterilizer's uniform steam-air mixture and avoid processing. Sterilization temperature can vary from 110-130OC for 10-30 minutes in the time combination in retorts. For labelling and storage, sterilised containers are then cooled and brought to room temperature. The turbidity test developed by Aschaffenburg is performed to ensure the product is sterile. This is an indirect test, and denatured whey proteins are weighed. Total denaturation means that the milk is sterilised sufficiently.

Sterilized Milk Consistency

Sterilized milk is rich in cream and has a distinct cooked taste (rich,nutty, caramelized). In colour, it is considerably browner than raw milk. The brown colour develops through Maillard reactions due to the formation of coloured pigments resulting from interactions between free amino groups of proteins and the lactose aldehyde group. The strength of the flavour and brown colour of the cooked product depends on the severity of the heat treatment. Sterilization of containers causes a depletion of almost half of the ascorbic acid (vitamin C) and a significant loss of thiamine (30-40 percent). Vitamin B12 is lost almost completely. It is not impaired by fat soluble vitamin A, carotene, riboflavin and nicotinic acid. It is only slightly influenced by the biological importance of proteins. Unless calcium chloride is applied externally, sterilised milk cannot be coagulated with the rennet.

FAQ: Questions:

1. What is the goal of sterilisation?
2. Explain in depth the sterilisation?

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Chapter - VII
Homogenisation

Homogenisation

Milk is an emulsion of the oil-in-water form in which the butter fat in the skim milk section is dispersed as fat globules. Globules with a diameter ranging from 2 to 6 µm form the main part of the fat volume. There may be a few fat globules which have a diameter of 10 µm. Milk fat also contains a large number of small fat globules with a diameter of up to 0.1 µm, although this does not increase the overall fat volume substantially.

Homogenization refers to the process of subdividing the fat globules by pushing the milk through a homogenizer. Homogenization has become a common industrial procedure, commonly used as a means of stabilising the emulsion of fat against the separation of gravity. In French, Gaulin, who invented the process in 1899, described it as "fixer la composition des liquides," meaning that it makes the composition of the liquid stable.

To minimise creaming, the aim of homogenization is to disintegrate or finely distribute the fat globules in the milk. Homogenization mainly causes fat globules to be disrupted into far smaller ones. It also decreases creaming and may also decrease the tendency of globules to clump or coalesce. All homogenised milk is basically processed by mechanical means.

Milk homogenised

Homogenized milk, according to the United States Public Health Service, is milk that has been processed in such a way as to ensure the breakdown of fat globules to such an extent that no visible cream separation occurs on the milk after 48 hours of quiet storage; and the fat percentage of milk in the top 100 ml of milk in a quart bottle or of proportionate volumes in containers of other sizes

Goals of Homogenization

Homogenization results in milk or milk products where the size of the fat globules is decreased to such a degree that no visible differentiation of the cream occurs in the milk. Basically, this process results in milk of uniform composition or consistency and palatability without any constituents being removed or added. Homogenization improves milk whiteness, since light is more easily spread by the larger number of fat globules. Milk that is homogenised is

Less sensitive to oxidised taste, and when entering the stomach, the softer curd produced by it helps digestion.

For any of the following purposes, homogenization is applied:

1. Creaming counteraction: The size of the fat globules should be significantly decreased in order to achieve this. A cream layer in the product, especially if the package is not transparent, may be a nuisance to the consumer.
2. Improving stability towards partial coalescence: The decreased diameter and the acquired surface layer of the fat globules are the cause of the increased stability of homogenised fat globules. In addition, in a cream layer, partial coalescence occurs in particular, and such a layer forms in homogenised products much more slowly.
3. Creation of desirable rheological properties: Homogenization cluster formation will significantly increase the viscosity of a substance such as cream. There is a higher viscosity of homogenised and subsequently soured milk (e.g., yoghurt) than unhomogenized milk. This is because the fat globules in the accumulation of casein micelles are now partially coated with casein micelles.
4. RECOMBINATION OF MILK PRODUCTS: Butter oil must be emulsified at one stage of the process in a liquid such as reconstituted skim milk. However, a homogenizer isn't an emulsifying gadget. The mixture should therefore be pre-emulsified first, e.g. by vigorous stirring; the coarse emulsion produced is subsequently homogenised.

Homogeniser

Homogenizers are high pressure, each with a sanitary head on which the homogenising valves are installed by reciprocating pumps. To supply the feed to the valve, positive displacement pumps are required. Generally, homogenizers have either three or five pistons, driven by connecting rods from a crank shaft.

This is a machine that allows fat globules to be sub-divided. It consists of a high pressure between the homogenising valve and its seat through a narrow opening; the fat globules in the milk are thus sub-divided into smaller, more evenly sized particles. A strong pressure spring against the seat of the valve keeps back the homogenising valve. The valve and its seat are made of extremely hard material (e.g. stelite) and the contact faces are carefully ground to ensure that the valve is placed on its seat correctly. Either a single stage or a double stage are homogenizers.

The Homogenizer's process

Homogenizers of the typical type consist of a high-pressure pump, the so-called homogenizer valve, which pushes the liquid through a narrow opening.

A mixture of contributing variables such as turbulence and cavitation achieves the disintegration of the initial fat globules. A four- to six-fold rise in the interfacial surface area of the fat/plasma is followed by this. With the original membrane content, the newly formed fat globules are no longer fully hidden. Instead, a mixture of proteins adsorbed from the plasma process is added to them.

Homogenization is achieved by pushing through a small slit, which is just slightly wider than the diameter of the globules themselves, all of the milk at high pressures. The velocity can be 100 to 250 m/s in the narrowest slit. High shearing pressures, cavitation and micro-turbulence may be caused by this. The globules are deformed, then become wavy and then disintegrate.

Theories for Homogenization

Over the years, several hypotheses of the high pressure homogenization process have been raised. Two hypotheses have existed for an oil-in-water dispersion such as milk, where most droplets are less than 1 µm in diameter. Together, they offer a clear description of the impact on the homogenising effect of various parameters.

The theory of globule disruption by turbulent eddies ('micro whirls') is focused on the fact that in a liquid moving at a high velocity, several small eddies are formed. Smaller eddies have greater velocity. The droplet will break up if an eddy encounters an oil droplet of its own size. This theory forecasts how the homogenising effect differs with the pressure of homogenization. In several investigations, this relationship has been shown.

On the other hand, the cavitation theory argues that the shock waves produced when the steam bubbles implode disrupt the droplets of fat. According to this theory, as the liquid exits the gap, homogenization occurs, so the back pressure that is necessary for cavitation control is essential for homogenization. In fact, this has also been seen. Without cavitation, however, it is possible to homogenise, but it is less successful.

In a processing line, the homogenizer. In general, in a heat exchanger, the homogenizer is put upstream, that is, before the final heating portion. The homogenizer is normally put upstream in indirect systems when processing UHT milk, but often downstream in direct systems, i.e. on the aseptic side after UHT treatment. In the latter case, with special piston seals, a sterile steam condenser and special aseptic dampers, the homogenizer is aseptic in nature.

For indirect UHT systems, however, the downstream position of the homogenizer is recommended if milk products are to be processed with a fat content greater than 610 percent and/or with an increased protein content. The explanation is that fat clusters and/or agglomerates (protein) form at very high heat treatment temperatures with increased fat and protein content. The aseptic homogenizer located downstream breaks up such clusters/agglomerates.

Total homogenization of streams

The most widely used method of homogenization of UHT milk and milk destined for cultured milk products is full stream or complete homogenization.

Prior to homogenization, the fat content of the milk is standardised, as is the solids-non-fat content in some cases, e.g. in the processing of yoghurt.

Homogenization in part

For energy and equipment savings, partial homogenization is used. The milk is divided into skim milk and fat, and the cream is homogenised and combined with the milk that has been removed.

Partial stream homogenization means that there is no homogenization of the entire skim milk body, but only of the cream along with a limited proportion of skim milk. This method of homogenization is applied primarily to the pasteurised milk industry. Reducing running costs is the underlying explanation. Owing to the smaller volume going through the homogenizer, overall power consumption is reduced by some 80 percent.

Homogenization of single-stage and two-stage

Homogenizers may be fitted with either one or two series-connected homogenising units, thus the single-stage homogenization and twostage homogenization names.

The entire homogenization pressure (P1) is used over the first unit in both single-stage homogenization and two-stage homogenization.

The back pressure (P2) is produced by the process during single-stage homogenization. The back pressure (P2) is produced by the second stage during two-stage homogenization. In this case, the back pressure can be selected to achieve the optimum efficiency of homogenization. The best results are obtained using modern devices when the P2/P1 relationship is around 0.2. The second stage also decreases noise in the outlet pipe and vibrations.

Single-stage homogenization may be used to homogenise products that require high viscosity with a high fat content (certain cluster formation).

In order to achieve optimum homogenization results and to break up fat clusters in products with a high fat content, two-stage homogenization is mainly used.

Homogenization-affecting factors

1. Homogenization temperature: milk should have a temperature above the melting point of fat, i.e. above 330C, at the time of homogenization. This is because, for proper subdivision, fat should be in the liquid state.
2.

Questions:

1. What is homogenization? Explain is the purpose of homogenization.
2. Explain the factors affecting homogenization.
3. Explain the objectives of homogenization and types of homogeniser.

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Chapter-VIII
STANDARDIZATION OF MILK

STANDARDIZATION OF MILK

Introduction

Many milk processes require the standardisation of the chemical composition of milk intended for market purposes or the manufacture of milk products. Standardizing milk may require only one component (usually fat) to be controlled while allowing the others to concurrently vary or regulate two or more components.

Standardizing

It may be defined as the adaptation to a nominated level of one or more of the milk constituents. This usually means reducing the content of butterfat in the retail milk industry by adding skim milk or by eliminating cream.

Targets

• To satisfy the legal specifications for unique milk/dairy products.

• To offer a standardised product to the customer.

Ensuring quality in production.

The addition of skim milk increases the amount of milk available for sale and the absence of cream makes it possible to manufacture other milk products with added value, such as table cream, butter or other high-fat products.

Calculation Techniques

The proportions of the different ingredients of the known composition to be combined must typically be calculated for the standardisation of milk or cream for the manufacture of the product. This can be done by:

• Pearson's Square method

• Algebraic Equations

The square method of Pearson

Draw a square and put the desired fat percentage in the middle of it. Place the fat percentage of the materials to be blended on the left-hand corners of the square. Next, subtract the number in the middle from the larger number on the square's left-hand side and put the rest on the right-hand corners diagonally opposite. The number on the right side now indicates the number of parts in the resulting mix of each of the original components that must be combined in order to have the desired fat content. The upper right-hand corner number refers to the parts of the material whose fat test was put in the upper left-hand corner, and the lower right-hand corner number refers to the parts of the material whose fat test was placed in the lower left-hand corner. If the numbers on the right are applied, parts of the finished product will be represented by the sum obtained.

Standardization Approaches

For standardisation, there are three approaches. These are batch standardisation, ongoing and automatic. Both of them involve separating whole milk into skim milk and cream and then mixing only the necessary amounts.

1. Standardization by batch

It is a form most widely used in dairies. Raw milk is stored in a silo and is tested for its fat content. It extracts a certain amount of milk and divides it into skim milk and cream. By calculation (or from graphs), the amount of skim milk or cream required is calculated and then applied to the bulk milk under continuous agitation. To verify whether the fat content is according to the target figure or not, the bulk milk is retested. If it is not, further changes are made before the batch is correctly standardised. The batch standardisation demerits are the time taken for agitation, testing and final blending.

2. Standardization underway

In conjunction with a measuring unit, continuous standardisation employs an inline sampler that tests, calculates and shows the fat material every 20 seconds. Before the sampling point, the operator observes the displayed fat content and changes the values to blend the skim milk or cream into the milk line to improve the fat content to the appropriate amount.

3. Standardization automatic

It is an extension of the constant mechanism. A microprocessor/controller unit connected to the sampler/tester device replaces the separator. Information about the desired fat content and flow rates of whole and skim milk is available from the microprocessor / controller device. It receives the sampler/tester system signals and responds by opening or closing a valve that controls the amount of skim milk added to the whole milk. Time and labour savings and ensuring more precise standardisation than other strategies are the merits of this automated method. Standardization depends on proper sampling, precise fat content testing, efficient separation and the right amount of skim milk or cream required.

Computer Tri-process

The Tri-process machine is designed for the clarification, separation and standardisation of milk in a single unit. The general configuration is close to that of the regular separator for creams. Inside the discharge lines of cream and skim milk, the tri-process separator has external valves. In the cream outlet, which regulates the cream flow rate, a precise needle valve is fixed. From the cream discharge line to the skim milk discharge line, a bypass line is connected. There is a needle valve on this bypass line that will control the flow of the cream going through the bypass line. The cream outlet line has a cream metre installed.

The needle valve in the bypass line is calibrated to such a position for the standardisation of milk to the correct fat content that the bypass cream would result in the desired fat percentage in the standardised milk when combined with skim milk.

FAQ: Questions:

1. What is the Standardisation Objective?
2. Explain in depth the standardisation?

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Chapter-XI

Fortification of milk and milk products

Fortification of milk and milk products

Milk and milk products are a good medium for fortification. An successful way to reduce micronutrient shortages could be to fortify foods with vitamins and minerals. Key steps in the design and consideration of the programme are the selection of necessary vehicles for fortification. Due to its acceptance by a wide community in all income classes of the population, milk and milk products were considered to be the best vehicle for micronutrient fortification.

Milk is usually the best carrier since vitamins A and D are soluble in fat and milk is a good source of calcium that is compatible with bone health messages. For several years, it has been successfully fortified with vitamins A and D.

The addition of vitamin D to margarine has been required in some countries, but this is typically for purposes of achieving nutrient equivalence with butter and not as an overt fortification intervention to compensate for a drop in vitamin D's primary source.

Fortification of Liquid Milk and Milk Powder Processed

Skimmed milk fortification with vitamins A and/or D is mandatory in many countries. In the United States, in addition to vitamins A and D, some dairies voluntarily fortify milk with vitamins C and E and calcium, and dried milk and flavoured milk powder are also fortified with vitamins A and D, calcium, and iron. Importantly, the fortification of milk and milk products may be tailored to meet the nutritional needs of particular target groups, such as children or the elderly. Vitamin D can be applied to both 'fat-rich' products, such as whole milk or cheese, and 'fat-poor' foods, such as skim milk, fat-free yoghurt, orange juice, etc., although it is a fat-soluble vitamin. FSSAI introduced the regulations on food fortification in India and approved fortification of vitamin A and vitamin D in phase I standardised, toned, double toned or skimmed milk and also suggested fortification in milk of the micronutrients Ca, Zn, Mg and Omega 3 by 2019-2020.

Iron fortification of milk has been introduced for several years by Chile and Argentina. Following the observation of a high prevalence of hypovitaminosis D in the elderly, some dairies in Ireland fortified milk with vitamin D and calcium. In order to satisfy the dietary and regulatory criteria, most vitamins and minerals are added to infant formulas.

Dairy products have become the most common delivery vehicles for a range of nutritious and functional ingredients, from fortification of vitamins and minerals to the incorporation of bioactives to promote health benefits. It is easy to understand why vitamins and minerals have been introduced into these products, because dairy products are a natural part of our diet.

Fortification of cheese and other fermented products containing milk

Fortified foods are permitted in the USA for cheese and cheese products. 81-89 IU/100g, Acidified Milk & Cultured Milk 42 IU/100g, Yoghurt 89 IU/100g with Vitamin D can be fortified by cheese and cheese products in the USA. In Canada, milk fortification (180 IU/250 mL), milk alternatives and margarine (530 IU/100 gm) and a few vitamin D fortified yoghurts are required by law. Vitamin D3 stability was 91 percent and 55 percent during cheese processing and ageing of cheddar cheese and low-fat cheese, and vitamin D3 stability was >90 percent in fortified foods, including high-temperature short-term processed 2 percent milk, UHT (ultra-high-temperature processing; heating milk for 1-2 s, at >135 °C), processed 2 percent fat chocolate milk and low-fat straight milk Folic acid, lycopene, magnesium, polyphenols, probiotics and omega-3 and 6 fatty acids can also be fortified with cheese.

Microencapsulation is an effective technology used during processing and contact with food matrices to distribute these nutrients to prevent losses. In Germany, the use of iodised salt to enrich cheese with iodine has been authorised. Vitamin A is not appropriate for fortification in a high acidic and low pH product such as yoghurt. Iron fortified yoghurt has a relatively high bioavailability of iron, but the catalytic role of iron and the appearance of iron are due to the oxidised and metallic taste found with salts. Chocolate milk was reinforced by iron and had flavour properties that were appropriate. As a source of calcium in yoghurts and other dairy products, tricalcium citrate can be used at concentrations greater than 1 g/L of calcium. It is of rising interest to fortify yoghurt or dairy products with fibre in order to produce functional foods with health benefits and enhance their versatility.

Fortification specifications'

1. Heat, light, humidity and oxidising and reducing agents are susceptible to vitamins. Overages must be taken into account depending on the circumstances of manufacturing, packaging and storage.
2. Reasonable fortifying agents are chosen on the basis of the bioavailability of the active compound and the food matrices.

3. Vitamin-Vitamin Interactions: Four of the 13 vitamins have been described with deleterious effects as having interactions with each other. There are ascorbic acid (vitamin C), riboflavin (vitamin B2), vitamin B12 and thiamin (vitamin B1).
4. Nutrients-Matrix Reactions: Nutrient availability/phase conversion occurs when the micronutrient responds to the food matrix, resulting in nutrient unavailability. 5. Security in Safety

The Factors:
Fortification shall be carried out at higher concentrations in compliance with stated guidelines and with validated evidence for its toxicity. Adequate protection should be given against the unnecessary ingestion of the fortifier. Fat soluble vitamins demonstrated toxicity at higher concentrations, unlike water soluble vitamins.

Scientific considerations for fortifying liquid milk
Vitamin fortification can be achieved by adding vitamins to the HTST constant level tank at different stages of the processing system, ideally after separation, including pasteurising vats, or continuously into the pipeline after standardisation and prior to pasteurisation in compliance with the guidelines of the manufacturer. This approach covers manufacturing order and GMP & GHP according to process specifications for the production and storage of fortified milk.

Fortification Process
1. Receiving fortifiers and premixes
Collect the necessary quantities of fortifiers from the store after they have been found to meet the specifications and other general requirements of QA compliance.
To obtain full shelf life, store fortificants as per supplier's direction/product labelling specifications.

2. Premix and Processing Planning
Uh. 2.1. Phase of Batch
Take aliquot milk quantity (~200ltr/Kg of fortifying agent) as suggested by suppliers.
To accurately measure vitamins for inclusion and weigh the necessary amount, care must be taken to avoid adding back concentrate.
The Milkfortificant Premix is ready for bulk fortification by mixing the entire volume by stirring.
Mix 30 percent of the overall batch of fortified milk to be processed with the above Milk-fortificant Premix.

In the case of oily fortifiers, homogenise the quantity above. Homogenization of aqueous fortifiers is optional.

Upon standardisation, apply this homogenised premix to the total milk (70 percent remaining). By heating min 72 ° C/ 15 sec and immediate milk chilling to 4 ° C, pasteurise the entire volume of milk.

Uh. 2.2. Phase Continuous (Oily Blend)

• Premix must be kept in closed containers in an acceptable temperature environment during the continuous process.

• Following the standardisation step, the metering device/dosing unit shall be mounted to pump the exact quantity of the fortifier by adjusting its flow rate to the amount of the fortifier in the final product.

The pump must only be installed in order to work while the unit is in forward flow (the pump shall not be operational during the Flow Diversion).

To stop milk from being forced back into the line, use a check valve on the injection line. The pump displacement depends on this.

Check the calibration of the metre periodically, for both the pump and the tubing, by measuring the accuracy of the delivery rate. For peristaltic pump systems, use only correctly calibrated tubing and change the tubing periodically.

Storage vessels used to supply metering pumps with vitamin concentrate should be emptied on a regular basis.

For these tanks, pumps and tubing, a routine systematic cleaning and sanitising schedule must be maintained.

For uniform premix mixing, homogenization of milk by applying the necessary pressure is basically required.

Pasteurization of milk milk by heating at min 72 ° C / 15 sec and immediate milk cooling to 4 ° C.

2.3.-2.3. (Water Soluble/ Dispersible Dry Blend) Continuous Phase

Take aliquot milk quantity (~20ltr/Kg of fortifying agent) as suggested by suppliers. By stirring and ensuring full solubility of the dry vitamin blend, mix the above blend properly at 45 ° C or as per supplier advice.

Add this blend to the milk that is needed for standardised milk. 2.3.4.-2.3.4. By heating min 72 ° C/ 15 sec, pasteurise milk and instantly chill the milk to 4 ° C.

In the case of an aqueous-based combination, homogenisation is optional.

Oh. 2.4. Milk storage

• Pasteurized milk shall be processed in dedicated pasteurised silos/storage tanks upon approval by the QA for compliance with its chemical and biochemical requirements.

To assess the amount of fortifying agent(s) in the fortified milk, an exact quality control plan must be outlined.

Analyze completed goods at regular intervals. Results are to be stated in the International Vitamin Units.

General Premix Storage and Handling Specifications

Heat, light, humidity and oxidising and reducing agents are susceptible to vitamins.

Customizing the amount of concentrated vitamins/premix depending on the size of the batch, it is advised to use the full amount of premix when extracting it from the bottle.

• Premix/vitamin concentrate assays for bulk containers are carried out regularly.

• The vitamin c quantity

2. Preparation of Premix and Processing

2.1. Batch Process

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General Premix Storage and Handling Specifications

Heat, light, humidity and oxidising and reducing agents are susceptible to vitamins.

Customizing the amount of concentrated vitamins/premix depending on the size of the batch, it is advised to use the full amount of premix when extracting it from the bottle.

• Premix/vitamin concentrate assays for bulk containers are carried out regularly.

To ensure that the actual amount of concentrate used closely matches what is needed for the total product produced, the quantity of vitamin concentrate used must be reported and cross-referenced with the quantity of product enriched.

The stability of vitamins during storage needs to be monitored as per the instructions of the supplier.

Premixes must be kept in amber / opaque bottles in a cool and dry spot, preventing direct sunlight exposure.

• Vitamin overages can be adequately applied to compensate for the loss during prolonged storage in the case of fortified goods.

FAQ: Questions:

1. What's the Fortification Objective?
2. Explain in depth the fortification steps?

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Chapter- X
Production of cream

Production of cream

Cream is a dairy product composed before homogenization of the higher-fat layer skimmed from the top of milk. The fat, which is less dense, inevitably rises to the top in un-homogenized milk. This method is accelerated in the industrial development of cream by the use of centrifuges called 'separators.' Depending on the overall content of butterfat, it is sold in many grades in several countries. It can be powder-dried for shipping to remote markets and contains high levels of saturated fat.

To differentiate it from cream skimmed from whey, a by-product of cheese-making, cream skimmed from milk may be called' sweet cream'. Whey cream has a lower content of fat and tastes saltier, tangy and "cheesy" Cream is typically sold partly fermented in many countries: sour cream, crème fraîche, and so on. In sweet, sour, salty and tangy dishes, both shapes have many culinary applications.

Cream created by cattle grazing on natural pasture (especially Jersey cattle) often contains some natural carotenoid pigments extracted from the plants they eat; this gives it a slightly yellow tone, hence the yellowish-white colour name: cream. This is the cause of the yellow colour of butter as well. Cream from goat milk, buffalo milk from water, whether from cows fed on grain or grain-based pellets indoors, is white.

Additives and refining

Cream may have added agents and stabilisers for thickening. Sodium alginate, carrageenan, gelatine, sodium bicarbonate, pyrophosphate tetrasodium, and alginic acid are thickeners.

Additional processing can be carried out. For example, when applied to coffee, cream has a propensity to create oily globules (called 'feathering'). The consistency of the cream can be improved by increasing the content of non-fat solids, which, while costly, can be accomplished by partial demineralisation and addition of sodium caseinate.

Name	Minimum milk fat	Additional definition	Main uses
Manufacturing cream	40%	Crème fraîche is also 40–45% but is an acidified cultured product rather than sweet cream.	Commercial production.
Whipping cream	33–36%	Also as cooking or "thick" cream 35% with added stabilizers. Heavy cream must be at least 36%. In Francophone areas: crème à fouetter 35%; and for cooking, crème à cuisson 35%, crème à l'ancienne 35% or crème épaisse 35%.	Whips into a creamy and smooth topping that is used for pastries, fresh fruits, desserts, hot cocoa, etc. Cooking version is formulated to resist breaking when heated (as in sauces).
Table cream	15–18%	Coffee cream. Also as cooking or "thick" cream 15% with added stabilizers. In Francophone areas: crème de table 15% or crème à café 18%; and for cooking, crème champêtre 15%, crème campagnarde (country cream) 15% or crème épaisse 15%.	Added as rich whitener to coffee. Ideal for soups, sauces and veloutés. Garnishing fruit and desserts. Cooking version is formulated to resist breaking when heated.
Half and half	10%	Cereal cream (at least one producer calls it coffee cream; another calls it Creamo™ light cream). Product with the most butterfat in the light cream category. In Francophone areas: crème à café 10% and sometimes crème	Poured over hot cereal as a garnish. Ideal in sauces for vegetables, fish, meat, poultry, and pasta. Also in cream soups.

		légère 10%.	
Light cream	3–10%	Light cream 6%. In Francophone areas: mélange de lait et de crème pour café 5%, Crémette™ 5% or crème légère 3% to 10%. A mixture of milk and cream.	5% product is similar to the richest Guernsey or Jersey milk. A lower fat alternative to table cream in coffee.

Other cream products

To separate the butterfat and buttermilk, butter is produced by churning cream. It is possible to do this by hand or by computer.

By whisking or combining air with more than 30 percent fat into milk, whipped cream is made to turn the liquid cream into a soft solid. Nitrous oxide can also be used for the manufacture of whipped cream from whipped-cream chargers.

Sour cream, popular in many countries, including the United States, Canada and Australia, is cream that has been subjected to a bacterial culture that produces lactic acid (0.5 percent +), which sours and thickens it (12 to 16 percent or more milk fat).

With a bacterial culture, crème fraîche (28 percent milk fat) is slightly soured, but not as sour or as dense as sour cream. The crème fraîche is similar to Mexican crema (or cream espesa).

Smetana is a Central and Eastern European sweet or sour cream derived from heavy cream (15-40 percent milk fat).

Clotted cream, popular in the United Kingdom, is made to produce a very high-fat (55 percent) product through a process that begins by slowly heating whole milk. This is similar to the Malai of India.

A cream product used in New Zealand to make Kiwi dip is reduced cream.

FAQ: Questions:

1. What does cream mean? Explain its processing.

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Chapter-XI
Production of Butter and Butter oil

Production of Butter

Butter is a dairy product made from the milk or cream components of fat and protein. At room temperature, it is a semi-solid emulsion which consists of about 80 percent butterfat. It is used as a spread, melted as a condiment at room temperature, and used as an ingredient in baking, sauce making, pan frying, and other cooking processes.

Butter can also be produced from the milk of other mammals, including sheep, goats, buffaloes, and yaks, most often made from cow's milk. It is made to separate the fat globules from the buttermilk by the churning of milk or cream. Butter is also applied to the salt and food colorings. It produces clarified butter or ghee, which is almost entirely butterfat, by producing butter, extracting the water and milk solids.

Butter is a water-in-oil emulsion arising from a cream inversion, where the emulsifiers are the milk proteins. When refrigerated, butter remains a firm solid, but softens at room temperature to a spreadable consistency and melts at 32 to 35 °C (90 to 95 °F) to a thin liquid consistency. The butter density is 911 grammes per litre (0.950 lb per US pint). The colour is usually pale yellow, but ranges from deep yellow to almost white. Its normal, unmodified colour depends on the feed and genetics of the source animal, but with food colorings such as annatto or carotene, the commercial processing process usually manipulates the colour.

Manufacturing

Butterfat is found in microscopic globules in unhomogenized milk and cream. These globules are covered by membranes made of phospholipids (emulsifiers of fatty acids) and proteins that prevent the milk fat from being pooled into a single mass. Butter is created by stirring cream, which destroys the membranes and makes it difficult to mix the milk fats, separating them from the other parts of the cream. Butters of various consistencies can be produced by changes in the production process, mainly due to the butterfat composition in the finished product. In three different types, butter contains fat: free butterfat, crystals of butterfat, and undamaged fat globules. Various proportions of these types result in various consistencies within the butter in the finished product; butters with many crystals are harder than butters dominated by free fats.

Little butter grains floating in the water-based portion of the cream are formed by churning. Buttermilk is called this watery liquid, although the most prevalent buttermilk today is a specifically fermented skimmed milk instead. The buttermilk is washed away; often the grains are rinsed with water to extract more buttermilk. The grains are then 'worked': pressed together and kneaded together. This is achieved using wooden boards called scotch hands, when prepared manually. This consolidates the butter into a solid mass and breaks up the buttermilk or water embedded pockets into small droplets.

Commercial butter is around 80% butterfat and 15% water; butter historically manufactured may have as little as 65% fat and 30% water. Butterfat is a mixture of triglycerides, a glycerol-derived testester, and three of the classes of fatty acids. When these chains break down into smaller elements, including butyric acid and diacetyl, butter becomes rancid. The butter density, around the same as ice, is 0.911 g/cm3 (0.527 oz/in3).

Butter is given a grade before commercial sale in some countries.

Groups Inside

Cream was generally obtained from several milkings before modern factory butter processing and was thus several days old and somewhat fermented by the time it was turned into butter. As cultured butter, butter made from a fermented cream is known. The cream naturally sours during fermentation as bacteria turn milk sugars into lactic acid. Additional aroma compounds, like diacetyl, are created by the fermentation process, which allows for a fuller-flavored and more "buttery" tasting product. Cultivated butter is now commonly made from pasteurised milk, the fermentation of which results from the introduction of Lactococcus and Leuconostoc bacteria.

Another approach developed in the early 1970s for producing cultured butter is to manufacture butter from fresh milk and then add bacterial cultures and lactic acid. The cultured butter flavour develops using this technique as the butter is aged in cold storage. This method is more effective for manufacturers, because ageing the cream used to produce butter takes considerably more space than simply storing the finished butter product. A technique for creating an artificial simulation of cultured butter is to apply directly to the fresh-cream butter lactic acid and flavour compounds; although this more successful approach is believed to simulate the taste of cultured butter, the substance created is not cultivated but instead flavoured.

In order to destroy pathogenic bacteria and other pathogens, dairy products are also pasteurised during processing. Sweet cream butter is called butter made from pasteurised fresh cream. In the 19th century, with the invention of refrigeration and the mechanical cream separator, production of sweet cream butter first became popular. Raw cream butter is called butter made out of fresh or cultured unpasteurized cream. Although butter made from pasteurised cream can last for several months, the shelf life of raw cream butter is about ten days.

Cultured butter is preferred in continental Europe, while sweet cream butter predominates in the United States and the United Kingdom. Cultured butter is often in the United States called "European-style" butter, although some dairies, especially Amish, produce and sell cultured butter. In the United States, industrial raw cream butter is almost unheard-of. In general, raw cream butter is only discovered at home by consumers who bought raw whole milk directly from dairy farmers, skimmed the cream themselves, and made butter with it. In Europe as well, it is rare.

It has produced many "spreadable" butters. At colder temperatures, these remain softer and are much simpler to use directly from refrigeration. By chemical modification of the finished product, some techniques change the composition of the butter's fat, some control the feed of the animals, and some add vegetable oil into the butter. "Whipped" butter is aerated by adding nitrogen gas, another substance intended to be more spreadable. Normal air is not used to prevent oxidation and rancidity.

Both salted and unsalted forms of all types of butter are sold. During fermentation, either granular salt or a potent brine is applied to the salted butter. The addition of salt serves as a preservative in addition to the better taste. A crucial element of manufacturing is the amount of butterfat in the finished product. Items marketed as' butter' must contain at least 80% butterfat in the United States. In fact, most American butters, averaging about 81 percent butterfat, produce slightly more than that. In general, European butters have a higher ratio of up to 85% .

With almost all of its water and milk solids extracted, Clarified Butter is butter, leaving almost pure butterfat. Clarified butter is created by heating butter to its point of melting and then allowing it to cool; the remaining components are separated by density after settling. The whey proteins form a skin at the top that is removed. From the combination of water and casein proteins that settle to the floor, the resulting butterfat is then poured off.

Ghee is clarified butter that has been heated after the water has evaporated to around 120 ° C (250 ° F), making the milk solids brown. The ghee is flavoured by this process and antioxidants that help protect it from rancidity are also generated. Because of this, under normal circumstances, ghee can be kept for six to eight months.

Butter Whey

As a by-product of cheese-making, cream can be separated (usually by a centrifugal separator) from whey instead of milk. Whey butter from whey cream can be made. The fat content of whey cream and butter is lower and tastes more salty, tangy and "cheesy" They are also cheaper than cream and butter, "sweet". The fat content of whey is low, so normally 1000 pounds of whey provides 3 pounds of butter.

Butter storage

Standard butter softens about 15 °C (60 °F) to a spreadable consistency, well above refrigerator temperatures. One of the warmer parts inside may be the "butter compartment" found in many refrigerators, but it still leaves very hard butter. Until recently, many refrigerators sold in New Zealand had a "butter conditioner", a compartment that stayed warmer with a small heater than the rest of the refrigerator, but still cooler than room temperature. Holding butter tightly wrapped delays rancidity, which is accelerated by light or air exposure and also helps prevent other odours from picking up. At refrigerator temperature, wrapped butter has a shelf life of several months. To further prolong its shelf life, butter can also be frozen.

'French butter dishes' or 'Acadian butter dishes' have a seal with a long inner lip that sits in a tub containing a small amount of water. Usually, when the dish is closed, the dish retains only enough water to submerge the inner lip. The lid is filled with butter. To keep the butter healthy, the water serves as a seal, and also prevents the butter from overheating in high temperatures. This approach lets butter sit on a countertop for several days without spoiling.

OF BUTTEROIL

Butteroil is a fat concentrate obtained mainly from butter or cream by extracting nearly all water and solids that do not contain fat. The terms milk fat and anhydrous milk fat are used synonymously with butteroil, dry butterfat and dehydrated butter fat, but cream is primarily the raw material used for their preparation. Among western dairy products, butteroil serves as the richest source of milk fat and is rich in fat soluble vitamins such as A, D, E and K.

COMPOSITION OF BUTTEROIL

Ingredients	Percent
Butter fat	99.5 – 99.8
Moisture	0.1 – 0.3
Acidity (Oleic acid)	0.2 – 0.5
Peroxide value	0.0 – 0.1

DIFFERENT METHODS OF PRODUCTION OF BUTTEROIL

Butter is a dairy product made from the milk or cream components of fat and protein. At room temperature, it is a semi-solid emulsion which consists of about 80 percent butterfat. It is used as a spread, melted as a condiment at room temperature, and used as an ingredient in baking, sauce making, pan frying, and other cooking processes.

Butter can also be produced from the milk of other mammals, including sheep, goats, buffaloes, and yaks, most often made from cow's milk. It is made to separate the fat globules from the buttermilk by the churning of milk or cream. Butter is also applied to the salt and food colorings. It produces clarified butter or ghee, which is almost entirely butterfat, by producing butter, extracting the water and milk solids.

Butter is a water-in-oil emulsion arising from a cream inversion, where the emulsifiers are the milk proteins. When refrigerated, butter remains a firm solid, but softens at room temperature to a spreadable consistency and melts at 32 to 35 °C (90 to 95 °F) to a thin liquid consistency. The butter density is 911 grammes per litre (0.950 lb per US pint). The colour is usually pale yellow, but ranges from deep yellow to almost white. Its normal, unmodified colour depends on the feed and genetics of the source animal, but with food colorings such as annatto or carotene, the commercial processing process usually manipulates the colour.

Manufacturing

Butterfat is found in microscopic globules in unhomogenized milk and cream. These globules are covered by membranes made of phospholipids (emulsifiers of fatty acids) and proteins that prevent the milk fat from being pooled into a single mass. Butter is created by stirring cream, which destroys the membranes and makes it difficult to mix the milk fats, separating them from the other parts of the cream. Butters of various consistencies can be produced by changes in the production process, mainly due to the butterfat composition in the finished product. In three different types, butter contains fat: free butterfat, crystals of butterfat, and undamaged fat globules. Various proportions of these types result in various consistencies within the butter in the finished product; butters with many crystals are harder than butters dominated by free fats.

Little butter grains floating in the water-based portion of the cream are formed by churning. Buttermilk is called this watery liquid, although the most prevalent buttermilk today is a specifically fermented skimmed milk instead. The buttermilk is washed away; often the grains are rinsed with water to extract more buttermilk. The grains are then 'worked': pressed together and kneaded together. This is achieved using wooden boards called scotch hands, when prepared manually. This consolidates the butter into a solid mass and breaks up the buttermilk or water embedded pockets into small droplets.

Commercial butter is around 80% butterfat and 15% water; butter historically manufactured may have as little as 65% fat and 30% water. Butterfat is a mixture of triglycerides, a glycerol-derived testester, and three of the classes of fatty acids. When these chains break down into smaller elements, including butyric acid and diacetyl, butter becomes rancid. The butter density, around the same as ice, is 0.911 g/cm3 (0.527 oz/in3).

Butter is given a grade before commercial sale in some countries.

Groups Inside

Cream was generally obtained from several milkings before modern factory butter processing and was thus several days old and somewhat fermented by the time it was turned into butter. As cultured butter, butter made from a fermented cream is known. The cream naturally sours during fermentation as bacteria turn milk sugars into lactic acid. Additional aroma compounds, like diacetyl, are created by the fermentation process, which allows for a fuller-flavored and more "buttery" tasting product. Cultivated butter is now commonly made from pasteurised milk, the fermentation of which results from the introduction of Lactococcus and Leuconostoc bacteria.

Another approach developed in the early 1970s for producing cultured butter is to manufacture butter from fresh milk and then add bacterial cultures and lactic acid. The cultured butter flavour develops using this technique as the butter is aged in cold storage. This method is more effective for manufacturers, because ageing the cream used to produce butter takes considerably more space than simply storing the finished butter product. A technique for creating an artificial simulation of cultured butter is to apply directly to the fresh-cream butter lactic acid and flavour compounds; although this more successful approach is believed to simulate the taste of cultured butter, the substance created is not cultivated but instead flavoured.

In order to destroy pathogenic bacteria and other pathogens, dairy products are also pasteurised during processing. Sweet cream butter is called butter made from pasteurised fresh cream. In the 19th century, with the invention of refrigeration and the mechanical cream separator, production of sweet cream butter first became popular. Raw cream butter is called butter made out of fresh or cultured unpasteurized cream. Although butter made from pasteurised cream can last for several months, the shelf life of raw cream butter is about ten days.

Cultured butter is preferred in continental Europe, while sweet cream butter predominates in the United States and the United Kingdom. Cultured butter is often in the United States called "European-style" butter, although some dairies, especially Amish, produce and sell cultured butter. In the United States, industrial raw cream butter is almost unheard-of. In general, raw cream butter is only discovered at home by consumers who bought raw whole milk directly from dairy farmers, skimmed the cream themselves, and made butter with it. In Europe as well, it is rare.

It has produced many "spreadable" butters. At colder temperatures, these remain softer and are much simpler to use directly from refrigeration. By chemical modification of the finished product, some techniques change the composition of the butter's fat, some control the feed of the animals, and some add vegetable oil into the butter. "Whipped" butter is aerated by adding nitrogen gas, another substance intended to be more spreadable. Normal air is not used to prevent oxidation and rancidity.

Both salted and unsalted forms of all types of butter are sold. During fermentation, either granular salt or a potent brine is applied to the salted butter. The addition of salt serves as a preservative in addition to the better taste. A crucial element of manufacturing is the amount of butterfat in the finished product. Items marketed as' butter' must contain at least 80% butterfat in the United States. In fact, most American butters, averaging about 81 percent butterfat, produce slightly more than that. In general, European butters have a higher ratio of up to 85% .

With almost all of its water and milk solids extracted, Clarified Butter is butter, leaving almost pure butterfat. Clarified butter is created by heating butter to its point of melting and then allowing it to cool; the remaining components are separated by density after settling. The whey proteins form a skin at the top that is removed. From the combination of water and casein proteins that settle to the floor, the resulting butterfat is then poured off.

Ghee is clarified butter that has been heated after the water has evaporated to around 120 ° C (250 ° F), making the milk solids brown. The ghee is flavoured by this process and antioxidants that help protect it from rancidity are also generated. Because of this, under normal circumstances, ghee can be kept for six to eight months.

Butter Whey

As a by-product of cheese-making, cream can be separated (usually by a centrifugal separator) from whey instead of milk. Whey butter from whey cream can be made. The fat content of whey cream and butter is lower and tastes more salty, tangy and "cheesy" They are also cheaper than cream and butter, "sweet". The fat content of whey is low, so normally 1000 pounds of whey provides 3 pounds of butter.

Butter storage

Standard butter softens about 15 °C (60 °F) to a spreadable consistency, well above refrigerator temperatures. One of the warmer parts inside may be the "butter compartment" found in many refrigerators, but it still leaves very hard butter. Until recently, many refrigerators sold in New Zealand had a "butter conditioner", a compartment that stayed warmer with a small heater than the rest of the refrigerator, but still cooler than room temperature. Holding butter tightly wrapped delays rancidity, which is accelerated by light or air exposure and also helps prevent other odours from picking up. At refrigerator temperature, wrapped butter has a shelf life of several months. To further prolong its shelf life, butter can also be frozen.

'French butter dishes' or 'Acadian butter dishes' have a seal with a long inner lip that sits in a tub containing a small amount of water. Usually, when the dish is closed, the dish retains only enough water to submerge the inner lip. The lid is filled with butter. To keep the butter healthy, the water serves as a seal, and also prevents the butter from overheating in high temperatures. This approach lets butter sit on a countertop for several days without spoiling.

OF BUTTEROIL

Butteroil is a fat concentrate obtained mainly from butter or cream by extracting nearly all water and solids that do not contain fat. The terms milk fat and anhydrous milk fat are used synonymously with butteroil, dry butterfat and dehydrated butter fat, but cream is primarily the raw material used for their preparation. Among western dairy products, butteroil serves as the richest source of milk fat and is rich in fat soluble vitamins such as A, D, E and K.

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Chapter-XII

Condensed milk and Powdered Milk

Condensed milk is cow's milk from which water has been removed (roughly 60% of it). It is most often found with sugar added, in the form of *sweetened condensed milk* (SCM), to the extent that the terms "condensed milk" and "*sweetened* condensed milk" are often used interchangeably today. SCM is a very thick, sweet product, which when canned can last for years without refrigeration if not opened. The product is used in numerous dessert dishes in many countries.

A related product is evaporated milk, which has undergone a lengthier preservation process because it is not sweetened. Evaporated milk is known in some countries as *unsweetened condensed milk*. Both products have a similar amount of water removed.

Production

Raw milk is clarified and standardised to a desired fat to solid-not-fat (SNF) ratio, and is then heated to 85–90 °C (185–194 °F) for several seconds. This heating process destroys some microorganisms, decreases fat separation and inhibits oxidation. Some water is evaporated from the milk and sugar is added until a 9:11 (nearly half) ratio of sugar to (evaporated) milk is reached. The sugar extends the shelf life of sweetened condensed milk. Sucrose increases the liquid's osmotic pressure, which prevents microorganism growth. The sweetened evaporated milk is cooled and lactose crystallization is induced.

Powdered milk

Powdered milk or **dried milk** is a manufactured dairy product made by evaporating milk to dryness. One purpose of drying milk is to preserve it; milk powder has a far longer shelf life than liquid milk and does not need to be refrigerated, due to its low moisture content. Another purpose is to reduce its bulk for economy of transportation. Powdered milk and dairy products include such items as dry whole milk, nonfat (skimmed) dry milk, dry buttermilk, dry whey products and dry dairy blends. Many dairy products exported conform to standards laid out in Codex Alimentarius. Many forms of milk powder are traded on exchanges.

Powdered milk is used for food and health (nutrition), and also in biotechnology (saturating agent).

History and manufacture

While Marco Polo wrote of MongolianTatar troops in the time of Kublai Khan who carried sun-dried skimmed milk as "a kind of paste", the first modern production process for dried milk was invented by the Russian doctor Osip Krichevsky in 1802. The first commercial production of dried milk was organized by the Russian chemist M. Dirchoff in 1832. In 1855, T.S. Grimwade took a patent on a dried milk procedure, though a William Newton had patented a vacuum drying process as early as 1837.

In modern times, powdered milk is usually made by spray drying nonfat skimmed milk, whole milk, buttermilk or whey. Pasteurized milk is first concentrated in an evaporator to approximately 50 percent milk solids. The resulting concentrated milk is then sprayed into a heated chamber where the water almost instantly evaporates, leaving fine particles of powdered milk solids.

Alternatively, the milk can be dried by drum drying. Milk is applied as a thin film to the surface of a heated drum, and the dried milk solids are then scraped off. However, powdered milk made this way tends to have a cooked flavour, due to caramelization caused by greater heat exposure.

Another process is freeze drying, which preserves many nutrients in milk, compared to drum drying.

The drying method and the heat treatment of the milk as it is processed alters the properties of the milk powder, such as its solubility in cold water, its flavour, and its bulk density.

Food and health uses

Powdered milk is frequently used in the manufacture of infant formula, confectionery such as chocolate and caramel candy, and in recipes for baked goods where adding liquid milk would render the product too thin. Powdered milk is also widely used in various sweets such as the famous Indian milk balls known as gulab jamun and a popular Indian sweet delicacy (sprinkled with desiccated coconut) known as chum chum (made with skim milk powder). Many no-cook recipes that use nut butters use powdered milk to prevent the nut butter from turning liquid by absorbing the oil.

Powdered milk is also a common item in UN food aid supplies, fallout shelters, warehouses, and wherever fresh milk is not a viable option. It is widely used in many developing countries because of reduced transport and storage costs (reduced bulk and weight, no refrigerated vehicles). Like other dry foods, it is considered nonperishable, and is favored by survivalists, hikers, and others requiring nonperishable, easy-to-prepare food.

Because of its resemblance to cocaine and other drugs, powdered milk is sometimes used in filmmaking as a non-toxic prop that may be insufflated.

Reconstitution

The weight of nonfat dry milk (NFDM) to use is about 10% of the water weight. Alternatively, when measuring by volume rather than weight, one cup of fluid milk from powdered milk requires one cup of water and one-third cup of powdered milk.

Nutritional value

Milk powders contain all 21 standard amino acids, the building blocks of proteins, and are high in soluble vitamins and minerals. According to USAID, the typical average amounts of major nutrients in the unreconstituted nonfat dry milk are (by weight) 36% protein, 52% carbohydrates (predominantly lactose), calcium 1.3%, potassium 1.8%. Whole milk powder, on the other hand, contains on average 25-27% protein, 36-38% carbohydrates, 26-40% fat, and 5-7% ash (minerals). In Canada, powdered milk must contain added vitamin D in an amount such that a reasonable daily intake of the milk will provide between 300 and 400 International Units (IU) of vitamin D. However, inappropriate storage conditions, such as high relative humidity and high ambient temperature, can significantly degrade the nutritive value of milk powder.

Commercial milk powders are reported to contain oxysterols (oxidized cholesterol) in higher amounts than in fresh milk (up to 30 µg/g, versus trace amounts in fresh milk). Oxysterols are derivatives of cholesterol that are produced either by free radicals or by enzymes. Some free radicals-derived oxysterols have been suspected of being initiators of atherosclerotic plaques. For comparison, powdered eggs contain even more oxysterols, up to 200 µg/g.

Questions:

1. What is condensed milk?
2. What is powdered milk and explain its process.

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Chapter-XIII

Technology of Yoghurt

Yoghurt is the most popular and widespread fermented milk product in the world. The word ‘yoghurt’ or ‘yogurt’ is derived from the Turkish word ‘Jugurt’. Yoghurt is a traditional food and beverage in the Balkans and the Middle East. However, its popularity has now spread to Europe and many other parts of the world. The product is popular with different names in different countries.

Definition

The general definition of yoghurt was given by Tamime and Deeth (1980). They defined yoghurt as a product resulting from milk by fermentation with a mixed starter culture consisting only of *Streptococcus thermophilus* and *Lactobacillus bulgaricus*.

FAO/WHO(1977) gave a more legal and scientific definition of yoghurt. Accordingly "Yoghurt is a coagulated milk product obtained by lactic acid fermentation through the action of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* from milk and milk products (pasteurized or concentrated) with or without the optional additions (SMP, WMP, whey powder, etc) and the final product must contain viable organism in abundance".

FAO/WHO expert committee also permitted the use of other suitable lactic acid bacteria in addition to *S. thermophilus* and *L. bulgaricus*for the manufacture of yoghurt. These organisms however, should only be used as the supplementing flora when justified.

In India, Yoghurt has been defined by PFA as under:

Yoghurt

It means a coagulated product obtained from pasteurized or boiled milk or concentrated milk, pasteurized skimmed milk and or pasteurized cream or a mixture of two or more of these products by lactic acid fermentation through the action of Lactobacillus bulgaricus and Streptococcus thermophilus. It may also contain cultures of Bifidobacterium bifidus and Lactobacillus acidophilus and other cultures or suitable lactic acid producing harmless bacteria and if added, a declaration to this effect shall be made on the label. The microorganisms in the final product must be viable and abundant. It may contain milk powder, skimmed milk powder, unfermented buttermilk, concentrated whey, whey powder, whey protein, whey protein concentrate, water soluble milk proteins, edible casein, and caseinates manufactured from pasteurized products. It may also contain sugar, corn syrup or glucose syrup in sweetened yoghurt and fruits in fruits yoghurt. It shall have smooth surface and thick consistency without separation of whey. It shall be free from vegetable oil/fat. animal body fat, mineral oil and any other substance foreign to milk.

Provided that titratable acidity as lactic acid shall not be less than 0.85 percent and not more than 1.2 percent. The specific lactic acid producing bacterial count per gram shall not be less than 10, 00,000.

Provided further that the type of Yoghurt shall be clearly indicated on the label otherwise standards of plain Yoghurt shall apply. The Yoghurt subjected to heat treatment after fermentation at temperature not less than 65°C shall be labelled as Thermized or Heat-Treated Yoghurt and shall conform to the above parameters except the minimum requirement of specific lactic acid producing count per gram;

Types of Yoghurt

The types of yoghurt that are produced world-wide can be divided into various categories, and the sub-divisions are usually made on the basis of:

1. **Legal / Standards/ Chemical composition: FAO/WHO (1973)**

   i. Full fat > 3% fat

   ii. Medium fat 0.5 to 3% fat

   iii. Low fat < 0.5%

   iv. Balkan yoghurt – 4.5 to 10% fat

2. **Method of production**

   i. Set yoghurt

   ii. Stirred yoghurt

   iii. Fluid yoghurt – diluted or stirred yoghurt (yoghurt with <11% T.S.)

3. **Flavours**

i. Naturalor plain yoghurt – traditional type with sharp, acidic taste

ii. Fruit yoghurt- addition of fruits & sweetening agents to plain yoghurt

iii. Flavoured yoghurt – in which synthetic flavouring & colouring agents are added.

4. **Post –incubation processing**

i. Pasteurized yoghurt

ii. Frozen yoghurt

iii. Dietetic yoghurts- may include less calorie yoghurt, low lactose yoghurt or vitamin/protein fortified yoghurt.

iv. Concentrated(>24% T.S.) and

v. Dried yoghurts (>90-94%).

Production of Yoghurt

The entire technology of yoghurt manufacture is centered at the 'care of culture'. The selection of raw material, processing conditions, environment, storage, etc. should be decided in such a way that the culture exhibits predictable behaviour. Here under the influence of each step during manufacture of fermented milk is discussed on the quality of the final product.

The manufacture of yoghurt involves several steps.

1. Selection of raw materials
2. Standardization
3. Homogenization
4. Heat processing
5. Inoculation
6. Incubation

7. Cooling

8. Post incubation processing

9. Packaging

1. The Selection of Raw Materials

Raw milk is the major raw material used in manufacture of yoghurt. During its selection it should always be kept in mind that a live microbial culture is required to proliferate in it. Hence, the raw milk selected for the product must support good growth of the culture. It should have following attributes too:

- It should be fresh,
- have normal composition,
- free from mastitis and other diseases,
- free from antibiotics and other inhibitors,
- free from off-flavours,
- has low bacterial count.
- Free from pre-enzymatic activities

2. Standardization and pre- treatments

Buffalo milk should be preferred for set types of product as it gives firm curd while cow milk may be good for stirred product, which will be smoother and uniform. The manufacturer has to standardize the milk to meet legal requirements for fat and SNF (Solids-not-fat). Technologically, good quality set yoghurt is obtained from the milk having 13-15% total milk solids. Fat do not have significant role to play infermentation, but contributes to integrated pleasant flavour and richness to the product. About 3% fat is sufficient to have good quality product, while SNF can be increased to 10-12%, preferably by concentration or by supplementation with skim milk powder.

The ingredients added during this standardization process should be carefully selected as poor quality ingredients can not make good quality product. If SMP,Whey powder, Butter or any other materials used for standardization has high microbial count, especially spore counts, it will increase load in fermented milk and the product will show defects early.

As such stabilizer is not needed in the product, but to increase the smoothness and decrease whey separation in stirred product, it can be added at the rate of 0.1-0.2%, while heating the milk. This should not add to the total microbial load of the product.

Pre-treatments like filtration/straining removes dirt, dust and extraneous matters that help in reducing the microbial load to a great extent. Fore-warming will lead to activation of microbes, but before they multiply, the milk should be heat processed so that the microbial count does not increase.

3. Homogenization

The milk maybe homogenized at 100 Kg/cm^2 at 60-70 °C. This is an optional step done in-between the final heat processing of milk. This process is useful as;

- it gives uniform mixing of all raw materials,
- reduce the problem of fat separation in curd,
- improves gel stability and
- improves digestibility.

From the microbiological point of view, homogenizer and the line connecting to it becomes an additional source of contamination. If it is not properly cleaned,it may add to the total microflora of the milk. The process of homogenization also breaks the clumps of microflora in milk and hence, if such milk is tested by plating methods, it apparently shows more cfu/ml, while actually the number of microflora might not have increased.

4. Heat processing

The milk intended for fermented product manufacture must be heated in the range of 80-95 °C for 5-30 minutes. Generally it is practiced at 80C for 30 min, or 85°C for 20 min or 90°C for 10 min or 95°C for 5 min. The heat treatment is made legal from public health point of view, as heat processing should destroy the pathogens likely to come in milk and make the milk safe for human consumption. However, such a high heat treatment is useful from many other angles too as shown below.

1. It supports good growth of the culture as it destroys other competing microflora giving free ground for the starters to proliferate.

2. It inactivates natural inhibitory substances in milk,

3. drives out oxygen

4. produce some growth stimulating agents for starters

5. Higher heat treatment denatures whey proteins which help in improving the gel stability

Heat treatment is the only severe treatment applied during the entire process of fermented milk manufacture, which can destroy microorganism. After this step,there is no other step which can destroy microorganisms and hence care should be taken that after heat treatment, the milk should not get contaminated by extraneous microorganism. That is why heat treatment is considered as critical control point (CCP) in HACCP program for yoghurt.

5. Cooling

Just after heating, the milk is cooled to incubation temperature, which is around 42-45°C. The cooling is essential before inoculation, because if the culture is added in hot milk, obviously it will die. Care should be taken that milk after cooling should be inoculated as early as possible. If the time gap before inoculation is more, the survivors of pasteurization will grow. The microbial count just after cooling should be minimum.

If set-product is to be prepared, the colour and flavour in appropriate concentration is mixed at this stage. In case of stirred product, flavouring is done while stirring. The milk is now ready for inoculation.

6. Inoculation

The milk is inoculated with active yoghurt cultures, *S. thermophilus* and *L. delbrueckii*s ubsp. *bulgaricus* at the rate of 2% (v/v) of milk. Usually both the cultures are added in equal proportion (1% each).

7. Filling in retail packs for set yoghurt

If set yoghurt is required, the inoculated milk is required to be packed in retail containers before incubation. The packing material must efficiently be treated, sanitized to minimize contamination. Risk of mould and bacterial spores decreasess helf-life.

8.Incubation

After adding culture in the milk, it is uniformly mixed without aeration. It is then incubated in bulk or in the same tank, if stirred product is to be made. If set-product is required, the milk is filled in retail containers before incubation. Incubation is purely a biological process during which the culture grows and brings necessary transformations in milk to get a desirable fermented product. Incubation temperature should be kept 42°C. The period of incubation varies between 3-6 h,depending upon the rate of acid production by the culture in the milk. However, the best end point to stop fermentation is just after the milk sets. Setting takes place at about 0.6% acidity and the remaining acidity required in the product can develop while cooling. During incubation, the milk is very sensitive to mechanical disturbances and other changes. Hence, it should not be disturbed.

9. Cooling

As soon as the curd sets or desired acidity in the product is achieved, it must be cooled. Cooling is done to reduce the rate of multiplication of starter cultures and stop their growth at the end of cooling. This is essential to avoid over acidification in the product. The final acidity desired in the product and total count of starter cells excepted in the product will depend on the rate of cooling and how much times it takes to reduce the temperature below 5°C.

The rate of cooling affects the quality characteristics of the product and should be decided according to the per cent lactic acid expected in the final product. Rapid cooling may lead to more contraction of gel and separate more whey, while too slow cooling may sour the product. In yoghurt, two stage cooling is preferred, i.e. in first stage cooling from 42°C to 20°C and in the second stage from 20°C to 5°C in cold store.

In the stirred products, cooling and stirring are simultaneously done. It is advisable to stir the product at lower temperature to reduce the problems of wheying-off. In most cases, the product is stirred at about 20°C and also blended with colour, flavour, fruits, nuts and other additives and then packed in retail containers. The product is to be stored at less than 5°C, until its consumption.

10. Packaging

The packaging for set product is done in retail containers before incubation. However, for stirred product, the packing is done during cooling. The packaging materials may be polythene pouches, polystyrene cups,bottles or cartons. All such packaging materials serve as additional source of contamination and their sterility should be ensured before packaging. Packaging materials should also prevent the contamination during storage and distribution. Yoghurt packaging machines are based on one of the following principles.

1. Volumetric level filling- When fluid yoghurt is poured in to glass bottles.

2. Volumetric piston filling- As applied to the packaging of stirred yoghurt in the plastic container.

This is more widely used, but the piston pump can cause some shearing of the coagulum. To minimize this reduction in viscosity, it is recommended to use low speed of filling and the use of a filling nozzle with a large orifice. It is also important that the design of the filling head should allow for a high standard of hygiene.

11. Storage

All packaged retail units are packed in larger cartoon and stored in cold stores. The yoghurt must be stored at less than 5°C to ensure inhibition of growth starters and non-starter microorganism. If there are temperature fluctuations or temperature increases during storage, the growth of culture as well other microorganisms may take place and it will make the product sour or produce other defects. Hence, maintenance of temperature during storage is very important.

The distribution of the finished product should always be through cold-chain.

A good quality yoghurt has shelf-life of 2-3 weeks days at 5°C.

Nutritional Value of Yoghurt

Milk contains well-balanced macronutrients including carbohydrate, fat, and protein and micronutrients including calcium, phosphorus, magnesium, and zinc (Table 21.1). Milk proteins have high nutritive value due to the favourable balance of essential amino acids. While fermentation of this milk for making yoghurt, most of these nutrients remain and hence yoghurt has excellent nutritive value.

While manufacture of yoghurt, quality and quantity of nutrients are affected by two ways.

- Changes due to modification/fortification

- Changes due to fermentation

Changes due to modification or fortification of supplementation of any ingredient can easily be calculated. However, changes during fermentation depend upon fermentation conditions and the type of cultures.

Changes due to Fermentation

- During fermentation some nutrients like lactose, protein, fat and some vitamins decrease while nutrients like lactic acid, peptides, amino acids, volatile flavour compounds, vitamins, enzymes and bacterial proteins increase.
- Fermentation improves the digestibility of the proteins. It helps in formation of softer curd and its digestibility is facilitated by presence of lactic acid.
- Availability of some minerals like calcium and phosphorous increases in yoghurt mainly because of the lactic acid and their more soluble forms.
- Vitamin content may increase or decrease depends upon the strain of the culture. Some yoghurt cultures are known to synthesize vitamin B2, B12, Folic acid, Niacin, etc and hence they can improve its nutritive value.

Therapeutic Value of Yoghurt

Yoghurt and related products have been used for health properties since very longtime. The normal yoghurt cultures do not survive passage through digestive system and do not implant in intestine and hence it do not give the benefits of ingestion of live probiotics. However, the metabolites of and cell contents of yoghurt cultures do confer several health benefits. Some of the applications of yoghurt for therapeutic benefits are listed below.

1. Used as therapeutic agents in gastro-intestinal disorders: Yoghurt flora is known to inhibit several food spoilage organisms and intestinal pathogens due to presence of several inhibitory substance and low pH. This helps in prevention of infections and control of several gastro-intestinal tract illness including diarrhea and constipation.

2. Can be digested by lactose intolerant people: Yoghurt has lower lactose due to fermentation and it also provides lactase from autolysed bacteria in gut and hence it helps in digestion of lactose.

3. May have hypocholesterolemic activity: There are some reports that yoghurt flora can reduce cholesterol in the body by different mechanisms. This can help in reducing the risk of heart diseases.

4. Anticarcinogenic activities: Yoghurt, especially having probiotic cultures are known to have some tumor inhibiting properties. They also reduce the activity of enzymes that convert pro-carcinogen to carcinogen in gut which reduces the possibility of colon cancer.

5. Immunostimulatory properties: Increase in specific and non-specific immune functions have been reported by consumption of fermented milks. Some reports on anti-mutagenic activity are also published.

6. Other applications: Yoghurt and other fermented milk products have been found to be useful in several other health conditions also. However, the therapeutic effect is dependant on the strain of the culture used for the preparation of the product. .

Quality Testing of Yoghurt

Yoghurt is tested in laboratory for various quality aspects. Various set of tests applied to judge the quality are given below:

- Physical tests: Physical appearance, free whey, presence of gas slits, package conditions, etc.
- Organoleptic tests: Colour & appearance, body& texture, flavour.
- Chemical tests: Titratable acidity, pH, presence of flavour compounds, flavour, etc.
- Microbiological tests: Microscopic examination, starter bacterial count, Coli form count, Yeast-mold count, etc
- Tests for specific properties: If any specific property or function is claimed from the product, a test to justify is required to be done.

Shelf-Life

Shelf-life of a good quality yogurt is 2-3 weeks at refrigeration temperature. The produce is required to be stored in cold conditions and transported and distributed in cold chain, otherwise several defects develop and the shelf-life is reduced.

Defects in Yoghurt

Defects in yoghurt can be classified as;

1. Appearance defects
2. Body & texture defects
3. Flavor defects
4. Acidification defects
5. Storage related defects.

Standards for Yoghurt and Quality Requirements

In India, Yoghurt has been defined by PFA as under:

"YOGHURT" means a coagulated product obtained from pasteurized or boiled milk or concentrated milk, pasteurized skimmed milk and or pasteurized cream or a mixture of two or more of these products by lactic acid fermentation through the action of Lactobacillus bulgaricus and Streptococcus thermophilus. It may also contain cultures of Bifidobacterium bifidus and Lactobacillus acidophilus and other cultures or suitable lactic acid producing harmless bacteria and if added, a declaration to this effect shall be made on the label. The microorganisms in the final product must be viable and abundant. It may contain milk powder, skimmed milk powder, unfermented buttermilk, concentrated whey, whey powder, whey protein, whey protein concentrate, water soluble milk proteins, edible casein, and caseinates manufactured from pasteurized products. It may also contain sugar, corn syrup or glucose syrup in sweetened yoghurt and fruits in fruits yoghurt. It shall have smooth surface and thick consistency without separation of whey. It shall be free from vegetable oil/fat. animal body fat, mineral oil and any other substance foreign to milk.

Provided that titratable acidity as lactic acid shall not be less than 0.85 percent and not more than 1.2 percent. The specific lactic acid producing bacterial count pergram shall not be less than 10, 00,000.

Provided further that the type of Yoghurt shall be clearly indicated on the label otherwise standards of plain Yoghurt shall apply. The Yoghurt subjected to heat treatment after fermentation at temperature not less than 65°C shall be labelled as Thermized or Heat Treated Yoghurt and shall conform to the above parameters except the minimum requirement of specific lactic acid producing count per gram;

India has witnessed a remarkable growth in milk production during the last few decades due to the success of the Operation Flood programme, which is one of the world's largest and successful integrated dairy development programs initiated in 1970s. It has led India to emerge as the largest milk producer in the world, transcending a record level of 104.8 million metric tonnes (MMT) in 2008 accounting for 15% of the world's total milk production. An estimated 5% of milk produced in India is converted to paneer; production figure being 3,959 metric tonnes in the year 2002–03, which increased to 4,496 metric tonnes in the year 2003–04 exhibiting a growth of 13%.

Questions:

1. What is yoghurt? Explain the processing of yoghurt.
2. Explain the defects of yoghurt.

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Chapter-XIV

Technology of Cheese

Cheese:

The word cheeseis derived from the Old English 'cese' which in turn was derived from the Latin caseuswhich means correct or perfect thing. Cheese may be defined as the curd of milk separated from the whey and pressed into a solid mass. This definition of cheese is satisfactory but too limited and vague from a technical standpoint. Therefore, a relatively complete definition is as follows:

Cheese is the curd or substance formed by the coagulation of milk of certain mammals by rennet or similar enzymes in the presence of lactic acid produced by added or adventitious microorganisms, from which part of the moisture has been removed by cutting, warming and pressing, which has been shaped in mould and then ripened (also unripened) by holding for sometime at suitable temperatures and humidity.

The expansion of the numbers of types of cheese makes a simple definition of cheese difficult. Thus the definition, the curd produced from milk by enzyme activity and subsequent separation of whey from the coagulum does not cover whey cheese, lactic cheese, cream cheese and some of the cheeses produced by newer techniques, viz. ultrafiltration and reverse osmosis. The definition is, therefore, not universally acceptable.

Definition of Cheese

Cheese is the fresh or matured solid or semi-solid product obtained:

a) By coagulating milk, skim milk or partly skimmed milk, whey, cream or butter milk or any combination of these materials, through the action of rennet or other suitable coagulating agents and by partially draining the whey resulting from such coagulation, or

b) By processing techniques involving coagulation of milk and/or materials obtained from milk (provided that the whey protein casein ratio does not exceed that of milk) and which give an end product which has similar physical, chemical or organoleptic characteristics as the product defined under (a).

According to the FSSR (2011), cheese means the ripened or unripened soft or semihard, hard and extra hard product, which may be coated with food grade waxes or polyfilm, and in which the whey protein/casein ratio does not exceed that of milk. Cheese is obtained by coagulating wholly or partly milk and/or products obtained from milk through the action of non-animal rennet or other suitable coagulating agents and by partially draining the whey resulting from such coagulation and/or processing techniques involving coagulation of milk and/or products obtained from milk which give a final product with similar physical, chemical and organolepticcharacteristics. The product may contain starter cultures of harmless lactic acid and/or flavor producing bacteria and cultures of other harmless microorganisms, safe and suitable enzymes and sodium chloride. It may be in the form of blocks, slices, cut, shredded or grated cheese. FSSR (2011) has also defined cheese on the basis of ripening as follows:

(i) Ripened cheese is cheese which is not ready for consumption shortly after manufacture but which must be held for some time at such temperature and under such other conditions as will result in necessary biochemical and physical changes characterizing the cheese in question.

(ii) Mould ripened cheese is a ripened cheese in which the ripening has been accomplished primarily by the development of characteristic mould growth through the interior and/ or on the surface of the cheese.

(iii) Unripened cheese including fresh cheese is cheese which is ready for consumption shortly after manufacture.

Cheese or varieties of cheeses shall have pleasant taste and flavor free from off flavor and rancidity. It may contain permitted food additives and shall conform to the microbiological requirements prescribed in the regulation.

Classification of Cheese

Several schemes to classify cheese have been proposed to assist international trade and to provide compositional and nutritional information. The basis for such classification include age, type of milk, country of origin, ripening process/agents, important compositional varieties, like moisture and fat, general appearance, texture and rheological qualities. However, none of the above schemes is complete in itself. There are about 2000 names of cheeses. It is very difficult to classify the different cheeses satisfactorily, in groups. There are probably only about 18 types of natural cheeses. These are: Cheddar, Gouda, Edam, Swiss, Brick, Herve, Camembert, Limburger, Parmesan, Provolone, Romano, Roquefort, Sapsago, Cottage, Neufchatel, Trappist, Cream and Whey cheeses.

Such a grouping, though informative, is imperfect and incomplete. These can also be classified on the basis of their rheology, and according to the manner of ripening as shown below:

1) Very hard (grating) - Moisture < 35% on matured cheese and ripened by bacteria, e.g. Parmesan, Romano.

2) Hard - Moisture < 40%

a) Ripened by bacteria, without eyes: Cheddar

b) Ripened by bacteria, with eyes: Swiss

3) Semi-hard - Moisture 40-47%

a) Ripened principally by bacteria: Brick

b) Ripened by bacteria and surface microorganisms: Limburger

c) Ripened principally by blue mould:

i) External – Camembert

ii) Internal – Gorgonzola, Blue, Roquefort.

4) Soft - Moisture > 47%

a) Unripened – Cottage

b) Ripened – Neufchatel

COMPOSITION AND NUTRITIONAL VALUE OF CHEESE

Introduction

Cheese is a nutritious and versatile dairy food. It contains a high concentration of essential nutrients relative to its energy level. Its precise nutritional composition is determined by multifactorial parameters, including the type of milk used (species, breed, stage of lactation, and fat content) and the manufacturing and ripening procedures. In general, cheese is rich in the fat and casein constituents of milk, which are retained in the curd during manufacture. It contains relatively small amounts of the water-soluble constituents (whey proteins, lactose, and water-soluble vitamins), which partition mainly into the whey.

Protein

Cheese contains a high content of biologically valuable protein. The protein content of cheese ranges from approximately 4-40%, depending upon the variety. It varies inversely with the fat content of cheese. During cheese manufacture, most of the whey proteins are lost in whey and thus only casein remains in cheese. Casein is slightly deficient in sulphur-containing amino acids. Thus the biological value of cheese protein is slightly less than that of the total milk protein. Cheese protein is almost 100% digestible, as the ripening phase of cheese manufacture involves a progressive breakdown of casein, to water-soluble peptides and free amino acids. Hence, a significant degree of breakdown of cheese protein has occurred before it is consumed and subjected to the effects of gastrointestinal proteolytic activity. A range of bioactive peptides are released during proteolysis of cheese, which exert specific health benefit to the human body (e.g.the peptides that inhibit the activity of angiotensin-I converting enzyme which give rise to antihypertensive and immunomodulatory effects).

Carbohydrate

The principal carbohydrate in milk is lactose, most of which is lost in whey during cheese manufacture. Only trace amount of carbohydrate remains in the cheese, this too is hydrolysed by starter lactic acid bacteria. Cheese is therefore, a safe food for lactose-intolerant people.

Lipids

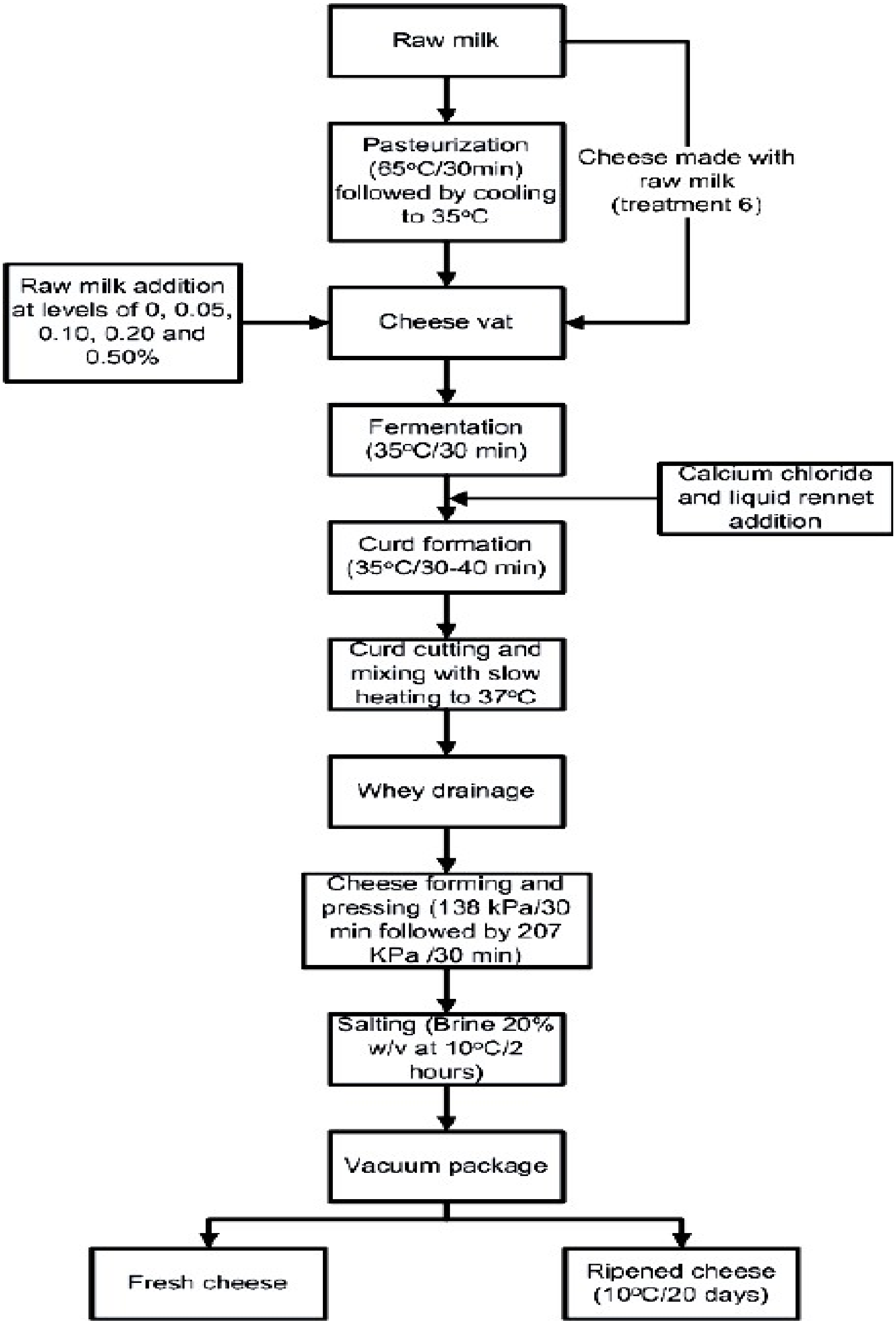
Most of the cheese varieties are rich in fat. Fat affects cheese firmness, adhesiveness, mouthfeel and flavour and also provides nutrition. It contributes a significant amount of both saturated and total fat to the diet. Cheese fat generally contains 66% saturated, 30% monounsaturated and 4%

polyunsaturated fatty acids. Thus, cheese represents a significant dietary source of both total fat and saturated fatty acids. The cholesterol content of cheese is a function of its fat content and ranges from approximately 10-100 mg/100 g, depending on the variety. Dietary cholesterol has much less influence on blood cholesterol level than dietary saturated fat. Thus, the cholesterol content of cheese is of lesser importance than its saturated fat content.

Vitamins and Minerals

As most of the milk fat is retained in cheese curd, the fat soluble vitamins remain in the curd while most of the water soluble vitamins are lost in whey. However, some microbial synthesis of B vitamins may occur in cheese during ripening. In general, most cheeses are good sources of vitamin A, riboflavin, vitamin B12, and, to a lesser extent, folate. Cheese contains negligible amounts of vitamin C.

Cheese is also an important source of several nutritionally important elements, including calcium, phosphorus, and magnesium. It is a particularly good source of bioavailable calcium, with most hard cheeses containing approximately 800 mg calcium/100 g cheese. Cheese has a potential role in supplying extra and highly bioavailable calcium. However, acid-coagulated cheeses (e.g., Cottage) contain considerably less calcium than rennet-coagulated varieties. Bioavailability of the calcium from cheese is equivalent to that from milk. It has been reported that 22.9, 26.7 and 25.4% of total calcium was absorbed from cream cheese, whole milk and yoghurt, respectively. Adequate calcium intake during childhood and in teenage years is important in development of high bone mass which may prevent osteoporosis in the later years.


Raw milk
Pasteurization (65ºC/30min) followed by cooling to 35ºC
Cheese made with raw milk (treatment 6)
Raw milk addition at levels of 0, 0.05, 0.10, 0.20 and 0.50%
Cheese vat
Fermentation (35ºC/30 min)
Calcium chloride and liquid rennet addition
Curd formation (35ºC/30-40 min)
Curd cutting and mixing with slow heating to 37ºC
Whey drainage
Cheese forming and pressing (138 kPa/30 min followed by 207 KPa /30 min)
Salting (Brine 20% w/v at 10ºC/2 hours)
Vacuum package
Fresh cheese
Ripened cheese (10ºC/20 days)

Questions:

1. Explain the processing of cheese.
2. Explain the defects of cheese
3. Explain the types of cheese.

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Chapter- XV

Packaging of dairy products

Cream, Butter and ghee contains a high percentage of fat, so they are very susceptible to spoilage. So packaging material used should be selected in such a way that it possesses good grease resistance, and barrier properties against oxygen and moisture.

1. CREAM

Cream is the concentrated form of milk fat

Characteristics of Cream:

1. Cream contains a high % of milk fat and is very susceptible to spoilage.
2. Moisture loss can occur if not properly packed
3. Prone to oxidative and lipolytic rancidity
4. Can absorb flavours

Characteristics of Packaging Material required:

1. Prevent light passage
2. Prevent water loss
3. Prevent oxygen transmission
4. Shall offer resistance for microbial contamination

In early 20th century waxed paperboard cartons were used as containers for cream. Now a days creams is packed in similar packages used for milk i.e. Newer cream packaging concepts include thermoformed packs made from linear polyethylene, polystyrene or polypropylene. These may be closed with a peel able lid or Snap-On cover. Tin plate containers have also been used for larger sizes. Whipped cream and synthetic formulations are sold in aerosol cans and polyethylene tubes.

Imitation cream made from soybeans and vegetable oils is often marketed in wax coated paper board cartons. Ultra-pasteurization has been applied to heavy and light creams. The product then goes for packing. A strong seal is necessary for productprotection. PE extruded or wax coated paperboard tubs are used to pack single portion cream. Sterilized/ UHT cream is packed in similar lines to that of UHT milk.

2. BUTTER

It consists primarily' of about 80% milk fat, 15% moisture and in table butter upto 3% common salt. Because of high moisture content butter is susceptible to mould growth and lypolytic rancidity

Characteristics of Butter

1. Due to high moisture content butter unlike solid fats is susceptible to mold growth.
2. Flavour and odour are easily absorbed by butter from its environment.
3. Deterioration of the butter may take place due to rancidity.
4. Butter has tendency to lose Moisture.

Requirement of Packaging

1. Non toxic, not harmful to consumer‘s health.
2. It should be grease/moisture proof.
3. Shall be barrier for Oxygen.
4. Low metallic content as metals favour oxidation of fat.
5. Shall not transmit light.

Packaging Material Used:

In India, butter is packed in bulk as well as in retail packages. For bulk packaging there is no standard method, and generally polyethylene bags/parchment paper along with corrugated boxes are used.

Al-foil 0.09 mm thick, surface treated with lacquer for protecting against corrosion: Alfoil/parchment or glassine paper (40-42 gsm): PVC or cardboard with a parchment insert can be used.

Indian Standard 2034 - 1961 gives specifications for tin cans of 200 g and 400 g capacity that are to be used for package of butter. They specify tinplate thickness of 0.24 mm and -0.27 mm respectively and minimum tin coating of 17 g/m2, besides many other requirements. Though tinplate containers are the best for product protection, owing to their high cost very little quantity of butter is packed in the tin containers. Flexible packaging materials like vegetable parchment paper or grease proof paper, aluminium foil, and paper board cartons which together give similar protection to the product are more commonly used.

Indian Standard 7161 - 1973 gives specifications for vegetable parchment paper or Grease Proof paper/ Aluminium foil laminate for wrapping butter. As vegetable parchment paper has good wet strength, generally paper of 45 gsm and above and aluminium foil above 0.009 mm thickness are used. As butter is highly susceptible to foreign odour, care must be exercised while choosing adhesive and printing inks used in the manufacture of the laminates.

There is also another IS: 8113-1976 standard for primary cartons for packaging of 100 g, 200 g and 250 g. butter slabs. Cartons protect butter while handling after packaging in primary Wrapper, in the distribution system. Since butter is stored in the refrigerator, cartons may be waxed with about 10 gsm wax on each side though it is not mandatory. Paperboard can be extrusion coated with PP. Injection-moulded pots and tubs of PP can also be used for packaging of the butter.

High-impact polystyrene or HIPS is also used in multilayer sheet extrusion with a variety of other polymers, like PE, PP, PET, PVDC and EVOH.

Large packs of 10, 20 and 50 kg butter are packed formerly in wooden barrels/boxes or parchment paper lined corrugated boxes. For better handling, easier storage, more efficient use of storage space and economy Fibre board boxes are introduced which are lined with parchment paper.

Latest packaging material that are being used are Shallow, 1-2 mil thick Al-foil trays with heat sealable PVDC-cellophane or other suitable barrier material. Aluminium PVDC/PS cups can also be used for butter. Butter chiplets are packed in lacquered Aluminium foil.

The standards for vegetable parchment paper used for the butter packing are:

Grammage: 41-45

Bursting strength: 1.8 ± 0.2 kg/cm2

Wet strength: 0.8 ± 0.2 kg/cm2

Grease resistance: Should pass the turpentine oil test

Acidity: 0.02% as H2SO4

pH of H2O extract: not less than 5.0

Brightness: 79.

3. GHEE

It is usually 100 per cent fat with little moisture (< 0.3 %), obtained by boiling butter at 1100C till all water is evaporated with a grainy texture and a characteristic flavour.

The product needs to be protected from chemical spoilage and rancidity caused by oxygen, light, heat, moisture and metal ions.

Characteristics of Ghee:

1. Easy to absorb flavour from its environment 2. Easily prone for oxidation 3. Prone for adulteration.

Packaging Material Should Have

1. Good fat resistance
2. Barrier properties against oxygen and moisture.
3. It shall be temper proof.

A major portion of ghee is packed in lacquered tinplate containers of capacities ranging from 250 litres to 15 litres / kilograms. Since the product is very sensitive to oxygen, the tinplate containers are filled to the brim without any air gap. Ghee packed in tinplate containers is fairly stable and has a shelf-life of about one year.

Alternate packages, which are plastic based, are now gradually replacing tins. For shorter shelf-life, 200 ml, 500 ml and 1 litre capacity pouches made of polyethylene film, multi – layer co-extruded films of LDPE/HDPE are used, which are economical. Aluminium foil laminate standy pouches are also commonly used for packaging ghee.

IS: 11352-1985 specifications for flexible packs for the packing of edible oils and vanaspati have been recommended for this purpose.

For long – term storage, stainless steel containers or tinplate cans are desirable. 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. Generally, plastic pouches are filled on automatic FFS machines. However, if the sealing surface is contaminated with the product, sealing of the pouch becomes difficult.

Recently it is packed in certain laminates and Bag - in - Box containers which comprises of a pre-sealed bag made of polyethylene and polyamide laminates fitted with a spout and cap housed in a CFB / Duplex board box. The bag consists of two plies which is sealed together on all four sides and the spout and cap assembly is heat sealed onto it. The bag is vacuum filled and inserted manually into the box. Seven-layer Nylon containing self-standing pouch with closure is also used. A laminate of HDPE / LDPE is used for packing ghee.

Another form is consisting of a multi-ply collapsible bag with a tap which can be housed in a rigid outer container. The container can be a box, a crate or a drum whose capacity varies between 3 and 200 litres. The bags and boxes are in collapsible form.

Nylon/ Styrene-based laminates, EVOH and EVAL are also being experimented as these materials could provide a fairly long shelf-life.

PACKAGING OF COAGULATED INDIGENOUS AND FERMENTED DAIRY PRODUCTS

Cultured milk products have various textures and viscosities, i.e. when liquid they are considered as beverages (Butter milk) and when semisolid they are spoonable products (Yoghurt)

The material used for packaging must be compatible with the special physical chemical and bacteriological properties of fermented milk. The packaging materials used are glass, polyethylene, complex card, LD / LLDP, HDPE cups, Co extrusion plastic complexes, polystyrene- EVOH (polyvinyl alcohol and ethylene co polymer, Polystyrene –PETG (polyethylene glycol terephthalate), tetrapack.

1. **Packaging of yoghurt:** Yoghurt has become very popular in many nations. In the United States yoghurt is packed in coated paper board containers. The product is automatically filled in polystyrene tubs and covered with 0.005mm aluminium foil. The inherent brittleness of polystyrene may become a problem. The terpene containing aroma of fruit yoghurt has an effect on polystyrene. Fruit acids may also cause pittingof unlacqurered aluminium lids. A polystyrene tub is an excellent package for yoghurt. It is economical, practical and widely used. Yoghurt is also being sold in expanded polystyrene foam tubs. Each tray holds 20 tubs of yoghurt. Trays are stackable and serve not only as display holders and light weight shippers but also hold during fermentation of yoghurt. This saves extra handling and repacking cost.

2. **Packaging of fermented milks (Buttermilk, sour cream, lassi):** LDPE sachets, polystyrene cups, polypropylene cups are used. Wax coated paper cups are used. Recently buttermilk, lassi and sour cream are packed in aseptic tetra packs. HIPS for stored products must never be employed as free fatty acids may lead to cracking of the material.

3. **Packaging of dahi/lassi:** The traditional pack so far was the earthenware pot with a loose cover of glassine or greaseproof paper. The earthenware pots are very heavy, easily breakable and because of oozing of water from its body, the product inside develops shrinkage cracks. Recently, injection moulded polystyrene and Polypropylene/ HIPS 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. Some private dairies are also packing dahi in LDPE pouches of 200ml capacity.

4. **Butter milk:** Butter milk is another most popular indigenous fermented milk product. It is packed in 200 ml polyethylene sachets. Recently some dairies are marketing butter milk in tetra packs.

5. **Lassi:** Lassi which is a sweetened butter milk product is packed in polystyrene cups with coated aluminium foil lids. The packaging materials such as earthen wares give firmness to

product. Others are glass jars, PS / PP cups, PVC lined HDPE. Tetrapak / Brick are recommended for Lassi, Basundi, Kheer

6. **Shrikhand:** Shirkhand is packed in polystyrene/PP Cups. HIPS are more common for 100 gm to 1 kg size which are sealed/capped/lined with Al-PE foil. Small manufacturers use lined (Glassine) paper board boxes. HDPE containers with lid ofLDPE made by injection moulding are also in use. PP or PE bags, Glassine paper lined containers are also used.

7. **Packaging of cheese:** Packaging requirements for natural cheese: Any material to be used for packaging natural cheese must give general protection, prevent moisture loss, improve appearance, protect against micro organisms and prevent oxygen transmission.

   Cheese is essentially a product with high fat and moisture content. Therefore, package used for cheese should prevent oxidation and mould growth. It should also have fat and grease resistance and be able to protect against microorganisms. Oxygen is eliminated by packing cheese in hermetically sealed containers in vacuum or inert gas atmosphere. Processed cheese is usually packed in aluminium foil in cubes with different shapes. Tinplate cans are used for 200 gms and above quantity. PVDC coated plastic films are suitable for cheese packaging as they provide good oxygen and moisture barrier properties.

   Cream cheese is packed in foil lined card board boxes of heat stable plastic packs. Saran is used as wrapping material for Neufchatel cheese. Air evacuation and gas flushing is used for cottage cheese, green cheese is packed by waxing and paraffining or alternatively vacuum packed in polyethylene or chyovac. Ripened cheese is packed in laminated cellophane film. Cheese consumer packs are generally consisting ofLacquered metal cans of laminated consisting of Nylon / PVDC / Copolymer or polyester/ PVDC / copolymer or Nylon / Polyethylene.

   Processed cheese is packaged hot metallic containers. Wax coated cellophane, A.P foil, polypropylene, PE, PVDE material is also used for packing processed cheese.

Packaging of Ice cream: The chief requirements of packages for ice cream are protection against contamination, attractiveness, ease of opening and reclosure and ease of disposal, protection against moisture loss and temperature fluctuations is desirable. Bilk ice cream is packed and hardened at a low temperature. Shaped bars are hardened prior to packaging.

Questions:

4. Explain the packaging of cream, butter, ice cream, cheese, yoghurt, shrikhand etc.
5. Explain the packaging of coagulated indigenous and fermented dairy products.

Contact Us:

University Campus Address:

Jayoti Vidyapeeth Women's University

Vadaant Gyan Valley, Village-Jharna, Mahala Jobner Link Road,

Jaipur Ajmer Express Way, NH-8, Jaipur- 303122, Rajasthan (INDIA)

(Only Speed Post is Received at University Campus Address, No. any Courier Facility is available at Campus Address)

Pages	: 84
Book Price	: ₹ 150/-

JPD Women University Press

Jayoti Publication Desk

Year & Month of Publication- 3/12/2021