CHEMISTRY OF DAIRY PRODUCTS

CHAPTER NOTES

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CONTENT

Module No.	Title
1	Chemical composition and legal Standards
2	Cream
3	Butter
4	Ghee
5	Khoa
6	Paneer
7	Dahi
8	Channa
9	Lassi
10	Chakka
11	Shrikhand
12	Cheese
13	Concentrated milk
14	Dried milk
15	Ice cream
16	Important Points

MODULE – 1

Chemical Composition and Legal Standards of Milk Products

Introduction

Dairy products or milk products are food products made from milk or containing milk. It is also known as "*lacticinia*". Dairy can contribute to a healthy diet, but you must be mindful about the type and quantity of dairy you consume. Dairy products offer protein, calcium, and many other nutrients, but they can also lead to digestive upset and contain high levels of saturated fat and sugar.

Some main Dairy Products

The dairy industry processes raw milk into an array of products including:

- Cream
- Butter
- Ghee
- Khoa
- Paneer
- Chhanna
- Dahi
- Lassi
- Chakka
- Shrikhand
- Cheese
- Condensed and Evaporated milk
- Dried milk
- Ice-cream and Frozen deserts

Let's we are going to brief study about all these products:

❖ Cream

→ Cream may be defined as:

I. That portion of milk which is rich in milk fat. Or,

II. That portion of milk into which has been gathered and which contains a large portion of milk fat. Or,

III. When milk fat is concentrated into a fraction of the original milk that portion is known as cream.

→ According to PFA rule 1976, cream contains not less than 25 percent milk fat.

Chemical composition of Cream

Constituents	Percentage
Water	70
Fat	Not less than 25%
Protein	2.5%
Lactose	3.5%
Ash	0.5%
Total Solids	28%
Solid not fat	6%

❖ Butter

→ Butter may be defined as a fat concentrate obtained by churning cream, gathering the fat into a compact mass and then working it.

→ According to PFA rule 1976, butter is the product obtained from cow or buffalo milk or a combination thereof, or from cream or curd obtained from cow or buffalo milk or a combination thereof, with or without the addition of common salt and annatto or carotene as colouring matter.

→ It should be free from other animal fats, wax and mineral oils, vegetable oils and fats.

→ It must contain not less than 80% fat, not more than 1.5% by weight of curd and not more than 3% by weight of common salt.

→ Diacetyl may be added as flavouring agent, but the total diacetyl content must not exceed 4ppm if used.

Chemical composition of Butter

Constituents	Percentage
Moisture	16.3
Fat	80.2
Salt	2.5
Curd	1.0

FSSAI Standards for butter

Product	Table Butter	Desi/cooking butter
Moisture	16%	-
Milk fat	80%	76%
MSNF	1.5%	-
Common Salt	3.0%	-

BIS standards for pasteurized butter

Characteristics	Table butter	White Butter
Milk fat, min	80	82
Moisture, max	16	16
Acidity, max	0.15	0.06
Curd, max	1.0	1.5
Common salt, max	2.5	-
Coliform count, max	5	5
Yeast and mould, max	20	20

❖ Ghee

According to FSSR 2011, Ghee means the pure heat clarified fat derived solely from milk or curd, desi butter, or cream to which no colouring matter or preservative has been added.

Chemical Composition of Ghee

Constituents %	Cow's Milk Ghee	Buffalo's Milk Ghee
Fat	99 - 99.5	99 – 99.5
Moisture	< 0.5	< 0.5
Carotene (mg/g)	3.2 – 7.4	-
Vitamin A (IU/g)	19 - 34	17 – 38
Cholesterol (mg/100g)	302 - 362	209 – 312
Tocopherol (mg/g)	26 - 48	18 – 31
Free fatty acid	2.8	2.8

FSSR Standards for ghee

Constituents	Quantity
Butyro refractometer reading at 40°C	40 to 43
Min. Reichert Value	24 to 26
% FFA as oleic acid (max)	3
% Moisture (max)	0.5
% Fat (min)	99 to 99.5

❖ Khoa

According to FSSR 2011, Khoa by whatever variety of names it is sold such as pindi, dhap, Danedar, mawa, or kava means the product obtained from cow or buffalo or goat or sheep milk or milk solids or a combination thereof by rapid drying.

- The milk fat content shall not be less than 30% on dry weight basis of finished product.
- It may contain citric acid not more than 0.1% by weight.
- It shall be free from added starch, sugar, and colouring matter.

Chemical Composition of khoa

Constituents %	Cow Milk Khoa	Buffalo Milk Khoa
Moisture	30.93	22.34
Total Solids	69.07	77.66
Fat	22.00	32.20
Proteins	19.10	17.70
Lactose	24.10	23.70
Ash	3.72	3.71

BIS Standards of Khoa

Characteristics	Variety of Khoa		
	Pindi	*Dhap*	*Danedar*
Total Solids % by mass (min)	65.0	60.0	55.0
Fat% by mass (on dry matter)	37.0	37.0	37.0
Total ash (% on dry matter basis)	6.0	6.0	6.0
Titrable acidity % max	0.8	0.9	0.6
Coliform Count/g (max)	90	90	90
Yeast and Mould Count/g (max)	50	50	50

❖ Paneer

Paneer means the product obtained from the cow or buffalo milk or a combination thereof by precipitation with sour milk, lactic acid, or citric acid. It shall not contain more than 70% moisture and milk fat content shall not be less than 50% of the dry matter.

FSSR-2011 standards for microbial quality of paneer

Total Plate Count	NMT 5,00,000/g
Coliforms	NMT 90/g
E. coli	
Salmonella	Absent in 1g
Staphylococcus aureus	NMT 100/g
Yeast and Mould Count	NMT 250/g
Listeria monocytogens	Absent in 1g

BIS Standards for paneer

Characteristics	Percentage
Moisture, max	60
Milk fat, min	50
Titratable acidity, max	0.5
Total Plate Count	NMT 50,000/g
Coliform Count, per g Max	90
Yeast and Mould per g Max	250

❖ Dahi

Dahi or curd is a semi solid product, obtained from pasteurized or boiled milk by souring, using harmless lactic acid or other bacterial cultures. Dahi may contain additional cane sugar. It should have the same minimum percentage of fat and solids-not-fat as the milk from which it is prepared.

Chemical composition of Dahi

Components	Whole milk Dahi	Skim Milk Dahi
Water	85-88	90-91
Fat	5-8	0.05-0.1
Protein	3.2-3.4	3.3-3.5
Lactose	4.6-5.2	4.7-5.3
Lactic acid	0.5-1.1	0.5-1.1
Ash	0.7-0.75	0.7-0.75

FSSR 2011 and BIS standards of Dahi

Characteristics	FSSR 2011	BIS
Acidity %	-	0.6 – 0.8
Total plate count	NMT 1000000/g	-
Coliform count	10 per g max	10 per g max
E. Colli	Absent in 1g	-
Salmonella	Absent in 25g	-
Staphylococcus aureus	NMT 100/g	-
Yeast and Mould	100 per g max	100 per g max
Phosphatase test	-	Negative

❖ Channa

According to FSSR-1511 chhana, the product obtained from the cow or buffalo milk or a combination thereof by precipitation with sour milk, lactic acid or citric acid. It shall not contain more than 70.0 per cent moisture and the milkfat content shall not be less than 50.0 per cent on dry matter. Milk solids may also be used in preparation of this product.

Chemical composition

Constituents	Cow Milk Channa	Buffalo Milk Channa
Moisture	53.4	51.7
Fat	24.8	29.7
Lactose	2.2	2.3
Proteins	17.4	14.4
Ash	2.1	1.9
pH	5.7	5.4

❖ Lassi

Lassi can be described as a fermented milk beverage obtained after the growth of selected lactic acid bacteria in heat treated milk followed by sweetening with sugar. It is consumed as a cold refreshing beverage in summer. It is prepared by breaking the curd in to fine particles by agitation, addition of sugar, water and optionally flavour.

Chemical composition of Lassi

Components	% In lassi
Fat	1.5 – 3.8
SNF	9
Sugar	13 – 15
Low methoxy pectin	0.5
Acidity	0.7 % min

❖ Dahi

Chakka is a fermented, intermediate dairy product obtained during the production of Shrikhand. Chakka can be described as strained dahi, in other words it is the curd mass obtained after removing whey from dahi, either through muslin cloth or basket centrifuge. Chakka is the base material for the production of Shrikhand and Shrikhand wadi.

Chemical composition

Constituents	%
Moisture	71-72
Fat	11.5
Proteins	12.5
Lactose	2.5-3.5
Ash	1.0
Acidity	2.1

FSSR and BIS requirement for chakka

Components	FSSR 2011		BIS	
	Skim milk chakka	Whole milk chakka	Skim milk chakka	Whole milk chakka
Total solid (min)	20	30	20	30
Milk fat	5 max	33 min	5 max	33 min
Milk proteins (min)	60	30	60	37
Acidity (max)	2.5	2.5	2.5	2.5
Ash (max)	5.0	3.5	5.0	3.5
SPC	Max 50,000			-
Coliform (max)	10	10	10	10
Yeast and mould (max)	10	20	20	20

❖ Shrikhand

Shrikhand is a popular fermented, sweetened, indigenous dairy product with semi-solid consistency and typical sweetish-sour taste.

Chemical composition

Constituents	%
Moisture	35-40
Fat	8.5-9.0
Proteins	9.5-12.5
Lactose	2.5-3.5
Sucrose	70-74
Ash	0.6-0.5
Acidity	1.0-1.3
pH	4.3-4.1

FSSR and BIS standards of Shrikhand

Particulars	BIS	FSSR
Total solids %by mass min	58	58
Milk fat %DM min	8.5	8.5
Milk protein %DM min	10.5	9.0
Acidity max	1.4	1.4
Sucrose %DM max	72.5	72.5
Ash %DM max	0.9	0.9
Coliform count cfu/g max	10	10
Yeast and mould cfu/g max	50	50

❖ Cheese

According to 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.

Approximate composition of some varieties of cheese

Variety	Moisture	Fat	Protein	Ash	Salt
Cheddar	37.5	32.0	25.0	2.0	1.5
Gouda	38.5	28.5	25.5	2.5	1.5
Swiss	39.0	28.0	27.0	2.0	1.5
Mozzarella	54.0	18.0	22.1	2.3	0.7
Cottage	79.5	0.3	15.0	0.8	1.0

Legal standards for cheese

Type of Cheese	Moisture, Maximum	Milk Fat (FDM), Min
Hard pressed cheese	39%	48%
Semi hard cheese	45%	40%
Semi soft cheese	52%	45%
Soft cheese	80%	20%
Extra hard cheese	36%	32%
Mozzarella cheese	60%	35%
Pizza cheese	54%	35%

❖ Concentrated Milk

Condensed milk means the product obtained from cow or buffalo milk or a combination thereof or from standardized milk by partially removing water and after adding cane sugar. It may contain added refined lactose, calcium chloride, citric acid and sodium citrate, sodium salts of orthophosphoric acid and poly-phosphoric acid (as linear phosphate) not exceeding 0.3 percent by weight of the finished product.

Evaporated milk means the product obtained from cow or buffalo milk or a combination thereof or standardized milk by partially removing water. It may contain added calcium chloride, citric acid and sodium citrate, sodium salts of ortho-phosphoric acid and polyphosphoric acid (as linear phosphate) not exceeding 0.3 percent by weight of the finished product.

Legal Standards of condensed milk according to FSSAI

Characteristics	Sweetened Condensed Milk	Sweetened Condensed Skimmed Milk
Total milk solids, min	31	26
Fat	Not less than 9	Not more than 0.5
Sucrose, min	40	40
Acidity, max	0.35	0.35
Bacterial count per gm, max	500	500
Coliform count per gm	Negative	Negative
Yeast and mould count per gm, max	10	10

Legal Standards of evaporated milk according to FSSAI

Characteristics	Evaporated milk	Evaporated Skimmed Milk
Total milk solids, min	31	26
Fat	Not less than 9	Not more than 0.5
Sucrose, min	-	-
Acidity, max	0.30	0.30
Bacterial count per gm, max	-	-
Coliform count per gm	-	-
Yeast and mould count per gm, max	-	-

❖ **Dried Milk**

Dried milk or milk powder is the product obtained by removing water from milk by heat or other suitable means, to produce a solid containing 5% or less moisture. The dried product obtained from whole milk is called dried whole milk or whole milk powder (WMP) and that from a skim milk is known as dried skim milk or skim milk powder (SMP) or Non-fat dry milk (NFDM).

Legal Standards according to BIS

Characteristics	WMP	SMP
Total milk solids, min	96.0	95.0
Fat	Not less than 26	Not more than 1.5
Moisture, max	4	5
Acidity, max	1.2	1.5
Bacterial count per gm, max	50,000	50,000
Coliform count per gm	90	90
Total Ash, max	7.3	9.3

❖ Ice Cream

According to the FSSA (2006), Ice Cream, Kulfi, Chocolate Ice Cream or Softy Ice Cream means the product obtained by freezing a pasteurized mix prepared from milk and /or other products derived from milk with or without the addition of nutritive sweetening agents, fruit and fruit products, eggs and egg products. It may also contain bakery products such as cake or cookies as a separate layer and/or coating. The said product may be frozen hard or frozen to a soft consistency; the said product shall have pleasant taste and smell free from off flavour and rancidity; the said product may contain food additives permitted in this regulation including Appendix A; the said product shall conform to the microbiological requirements specified in Appendix B; the said product shall conform to the following requirements by FSSR.

FSSAI Standards for Ice cream

Requirement	High Fat Ice cream	Medium Fat Ice cream	Low Fat Ice cream
Total solids	NLT 36%	NLT 30%	NLT 26%
Wt./vol	NLT 525	NLT 475	NLT 475
Milk fat	NLT 10%	MT 2.5 but LT 10	NMT 2.5
Milk protein	NLT 3.5	NLT 3.5	NLT 3.0

NLT: not less than; NMT: not more than; LT: less than; MT: more than

MODULE – 2
Cream

Introduction

Cream has been known since immemorial as the fatty layer that rises to the top of the milk when it stands undisturbed for some time. The production of cream in India in 1966 was estimated to be about 1.9% of the total milk production and 3.4% of the milk used to manufacture dairy products.

Cream is one of the most popular milk products handled in large quantities by the organized sector and unorganised sectors of the dairy industry.

In areas where milk collection, transportation, processing and distribution of the milk is not well organized the traders install a small cream separator and remove cream from the milk based on which producers are paid for the milk.

Definition

Cream can be defined as the portion of milk in which the milk fat is concentrated.

According to FSSAI, cream may be defined as:

I. That portion of milk which is rich in milk fat. Or,

II. That portion of milk into which has been gathered and which contains a large portion of milk fat. Or,

III. When milk fat is concentrated into a fraction of the original milk that portion is known as cream.

According to PFA rule 1976, cream contains not less than 25 percent milk fat.

Legal Standards for Cream

Chemical composition of Cream

Constituents	Percentage
Water	70
Fat	Not less than 25%
Protein	2.5%
Lactose	3.5%
Ash	0.5%
Total Solids	28%
Solid not fat	6%

Types of Cream

Cream may be broadly classified as:

Market cream used for direct consumption and Manufacturing cream used for the manufacture of dairy products.

The various types of cream are:

Table cream, Light cream, Coffee cream which contains 20 to 25% of the milk fat.

Whipping cream and Heavy cream which contains 30 to 40% milk fat.

Plastic cream which contains 65 to 85% milk fat.

Neutralization of Cream

Neutralization of cream refers to the partial reduction of acidity in cream.

The objectives of neutralization of cream are following:

1. To avoid excessive fat loss in buttermilk that result from churning highly acid pasteurized cream.
2. To guard against the production of an undesirable of flavour in cream
3. To improve the keeping quality of butter made from high acid cream.

The procedure for correct neutralization is followings:

1. Adoption of a definite standards of churning acidity.
2. Testing correctly for acidity
3. Correct amount of neutralizer to be added
4. Adding neutralizer to cream by the correct method
5. Checking results by re-testing acidity

Factors affecting Neutralization of cream:

1. Accuracy in sampling
2. Accuracy in testing
3. Accuracy in estimation of cream and neutralizer
4. Careful weighing the quantity of neutralizer.
5. Through mixing of neutralizer in cream prior to pasteurization.

Factors affecting quality of cream

The factors which affect the quality of cream are following:

1. Quality of milk
2. Transportation of milk
3. Hygienic condition during separation
4. Storage of cream
5. Transportation of cream

Ripening of Cream

Ripening of cream refers to the fermentation of cream with the help of desirable starter culture.

Fermentation means, strictly, the decomposition of carbohydrate by microorganism only. In the dairy industry the most important fermentation is lactic acid production or souring of milk while less important are those for the production of flavour, etc,

Objectives of ripening of cream

The main objective of ripening of cream is to produce butter with a pleasing, pronounced characteristics flavour and aroma uniformly from day-to-day.

Factors affecting Ripening

1. Type of starter used
2. Quality of milk
3. Fat content
4. Time and temperature
5. Quality of cream

Physico-chemical properties of cream

The physical chemical properties of cream are mentioned below:

a) Viscosity
b) Whipping quality
c) Specific gravity
d) Acidity

Viscosity

Viscosity may be defined as the resistance offered by the liquid to flow. It is an important property of cream from the commercial point of view.

Viscosity of cream may be affected by the following factors:

a. Fat percentage
b. Temperature
c. Separation condition
d. Homogenization
e. Cooling
f. Ageing
g. Clumping

Whipping quality

Whipping quality refers to the beating of cream to produce froth or foam.

Whipping quality of cream may be affected by the following factors:

a. Fat percentage
b. Whipping temperature
c. Separation temperature
d. Ageing
e. Homogenization
f. Acidity
g. Addition of stabilizers

Specific gravity

Specific gravity depends on its fat percentage. It is inversely proportional to the fat.

Acidity

The percent at titratable acidity of all fresh cream should be consistent with different percentage of the cream. There exists an inverse relationship between the percent fat and percent titratable acidity.

MODULE – 3

Butter

Introduction

- Butter leads amongst the milk products manufactured in developed dairying countries of the world today. Butter is a dairy product made by churning fresh or fermented cream. It is generally used as a spread and a condiment, as well as in cooking applications, such as baking, sauce making, and pan frying.
- Butter is a water-in-oil emulsion resulting from an inversion of the cream, an oil-in-water emulsion; the milk proteins are the emulsifiers.
- Butter remains a solid when refrigerated, but softens to a spreadable consistency at room temperature, and melts to a thin liquid consistency at 32–35 °C. It generally has a pale-yellow color, but varies from deep yellow to nearly white.
- Its unmodified color depends on the animals' feed and is commonly manipulated with food colourings in commercial manufacturing, most commonly annatto or carotene.

Definition

Butter may be defined as a fat concentrate, obtained by churning cream, gathering the fat into compact mass and then working it.

As per Codex, Butter is a fatty product derived exclusively from milk and/or products obtained from milk, principally in the form of an emulsion of the type water-in-oil.

As per FSSAI (2011), Butter means the fatty product derived exclusively from milk of cow and/or buffalo or its products principally in the form of water-in-oil type of an emulsion. The product may be with or without added common salt and starter cultures of harmless lactic acid and/or flavour producing bacteria. Table butter shall be obtained from pasteurised milk and/or other milk products which have undergone adequate heat treatment to ensure microbial safety. It shall be free from animal body fat, vegetable oil and fat, mineral oil and added flavour. It shall have pleasant taste and flavour free from off flavour and rancidity. It may contain food additives permitted in these Regulations. It shall conform to the microbiological requirements of the regulation.

Legal Standards

FSSAI Standards for butter

Product	Table Butter	Desi/cooking butter
Moisture	16%	-
Milk fat	80%	76%
MSNF	1.5%	-
Common Salt	3.0%	-

BIS standards for pasteurized butter

Characteristics	Table butter	White Butter
Milk fat, min	80	82
Moisture, max	16	16
Acidity, max	0.15	0.06
Curd, max	1.0	1.5
Common salt, max	2.5	-
Coliform count, max	5	5
Yeast and mould, max	20	20

Churning of cream

Churning is the process of converting cream into butter through appropriate mechanical manipulations leading to the conversion of oil-in-water (O/W) emulsion of cream into water-in-oil (W/O) emulsion desired in butter. The emulsion change accompanied by removal of buttermilk and working of butter yields the desired structure and texture in the product.

Theories of Churning

Various theories of churning explain the conversion of oil-in-water (O/W) emulsion of cream into water-in-oil (W/O) emulsion to form butter. These are discussed below:

- Phase reversal theory
- Foam Theory
- King's Theory

Phase reversal Theory

This theory is proposed by Fischer and Hooker's in 1927, the theory is therefore also referred as Fischer and Hooker's theory. According to this theory, churning is a phase reversal process that changes oil in water type emulsion to a water in oil type emulsion.

Foam's theory

This theory was put forward by Rahn in 1928. According to Rahn foam theory the presence of foam is essential for churning. Cream contains a foam-producing substance that gradually becomes solidified when cream is agitated. Fat in cream at churning time is completely crystallized and the pass in to the butter with their membrane intact and thus butter is a compact mass of fat globules in which butter milk, water and air are distributed as a small globule.

King's Theory

King's theory was proposed in 1930 and 1953 and it is regarded as the modern theory. According to this theory what happens during churning is midway between the phase reversal theory and foam theory.

Factors affect the churning

The factors which influence the churnability of cream can be classified into two groups:

i. The factors related to the initial character of the cream
ii. The conditions in the process of manufacturing

Factors related to the initial character of the cream includes

a. chemical composition of the butter fat
b. size of fat globules,
c. richness of cream
d. viscosity of cream

Factors related to processing conditions are

a. churning temperature
b. fullness of churn
c. speed of churn
d. design of churn

Butter Colour

Butter colours are required to manufacture uniform quality butter all the year round as the natural components (like carotene) responsible for colour in butter, varies according to many factors like season, breed, stage of lactation, feed among others.

Therefore, a calculated amount of colour is added in butter so that it does not influence varying natural colouring components present in milk or cream.

Types of Butter colour

Butter colours are classified based on their sources and vegetable butter colours and mineral butter colours.

1. **Vegetable butter colour**

   This class of butter colours is derived from plants. The most common is the colour obtained and extracted from the seed of the annatto plant (Bixa Orellana). The extract of vegetable butter color is made by boiling the annatto seed in oil for several hours. During the latter period of the process the heat is raised to a high temperature, about 115°C for extraction of annatto principle in permanent emulsion with oil. The mixture is then filtered through heavy canvas by gravity or under pressure.

2. **Mineral butter colour**

   The colouring principle of this class of butter colours is derived from harmless oil soluble coal tar dyes. This coal tar dyes are mixed with the neutral oil, boiled and filtered.

   The coal tar dyes certified by USDA are

   - Yellow A B (Benzeneazo- β- naphthylamine)
   - Yellow O B (Ortho- Toluneazo- β- naphthylamine)

   Mineral colors have a greater concentration of colouring principle and therefore less of the butter color is needed to produce desirable color in butter than vegetable colors. The emulsion of mineral butter color in oil is more permanent than vegetable butter colors.

Desirable properties of Butter Colour

- It should be free from ingredients injurious to health
- It should be free from undesirable odour and flavour
- Strength should be such that only a small quantity is required
- It should have such permanency of emulsion as to prevent settling out upon standing
- It must be oil soluble

MODULE – 4

Ghee

Introduction

- Ghee production forms the largest segment of India's milk consumption and utilization pattern.
- Ghee market is rising at the annual growth of 5%. About 28% of the total milk production is utilized to manufacture about one million ton of ghee per annum.
- The flavour of ghee cannot be surpassed, a fact known and taken to heart since the 8th century BC when it was first mentioned in Indian texts.
- Ancient Sanskrit literature describes ghee (*"ghrit")* as the food fi for gods and a commodity of enormous values. Ghee is a very popular product since ancient times and has had greater demand during festivals. Other ceremonial functions where use ghee in food has been considered delicacy due to its pleasing flavour and aroma. It is considered as the supreme cooking or frying medium.

Product Description

- Ghee is the clarified butter fat obtained from cow or buffalo milk. It is produced by heat desiccation of makkhan, butter or cream at 105℃ - 110℃.
- Heat induced changes in milk proteins/lactose during the clarification process impart a distinctive, pleasant cooked flavour to ghee.
- Ghee, or "desi" (indigenous) ghee, is the most widely used milk product in the Indian sub-continent.
- Ghee could be in liquid, semisolid and sometime in solid state based on the storage temperature.
- Ghee made from buffalo milk is whitish with greenish tinge and cow milk is golden yellow.

Definition

According to FSSR 2011, Ghee means the pure heat clarified fat derived solely from milk or curd, desi butter, or cream to which no colouring matter or preservative has been added.

Chemical Composition

Ghee is complex lipid of glycerides, free fatty acids, phospholipids, sterols, sterol esters, fat soluble vitamins, carbonyls, hydrocarbons, carotenoids (only in ghee derived from cow's milk). Its detailed chemical composition is given below:

Chemical Composition of Ghee

Constituents %	Cow's Milk Ghee	Buffalo's Milk Ghee
Fat	99 - 99.5	99 – 99.5
Moisture	< 0.5	< 0.5
Carotene (mg/g)	3.2 – 7.4	-
Vitamin A (IU/g)	19 - 34	17 – 38
Cholesterol (mg/100g)	302 - 362	209 – 312
Tocopherol (mg/g)	26 - 48	18 – 31
Free fatty acid	2.8	2.8

Legal Standards

FSSR Standards for ghee

Constituents	Quantity
Butyro refractometer reading at 40°C	40 to 43
Min. Reichert Value	24 to 26
% FFA as oleic acid (max)	3
% Moisture (max)	0.5
% Fat (min)	99 to 99.5

Agmark Standards for ghee

Parameters	Special Grade	General Grade	Standard Grade
Baudouine Test	Negative	Negative	Negative
Butyro-refractometer reading at 40°C	40-43	40-43	40-43
RM value	NLT 28	NLT 28	NLT 28
Polenske Value	1.0-2.0	1.0-2.0	1.0-2.0
Moisture Content	NMT 0.3%	NMT 0.3%	NMT 0.3%
% FFA (as oleic acid)	NMT 1.4	NMT 2.5	NMT 3.0

Physico-Chemical changes during manufacture

- Ghee consists of milk lipids and the richest source of milk fat of all Indian Dairy products. The constituents of ghee tend to vary with the method of its manufacture.
- Chemically ghee is a complete lipid of glycerides, 97-98% triglycerides. Small amount of di-and mono-glycerides are also present in traces. Also, cow milk ghee is different from buffalo milk ghee in terms of its composition.
- Fatty acid composition of buffalo milk ghee also varies from cow milk ghee. The amount of butyric acid is significantly higher in buffalo than in cow ghee.

- The levels of short chain fatty acids caproic to myristic are significantly higher in cow than buffalo ghee. In contrast, levels of palmitic and steoric are higher in buffalo than in cow ghee.
- Ghee made from buffalo milk is white (lack of carotenoids) with greenish tinges, and cow milk is golden yellow.
- The characteristic colour of buffalo fat has been attributed to tetrapyrozole pigments-biliverdin and bilivubin this pigment is conjugated to a protein in milk, but is released during the manufacturing process of ghee making.
- Thus, imparting yellowish-green colour to buffalo ghee. During manufacturing, water evaporates and fat in the cream or butter gets concentrated (curd particles (MSNF present in cream or butter) starts settling at the bottom during clarification process.
- Flavour formation in ghee happens during fermentation of cream and during clarification process. Colour development and granulation also happens during clarification for the subsequent packaging of ghee.

Factors affecting Keeping Quality of Ghee

Temperature of storage:

Higher the temperature of storage. Lower will be the keeping quality and vice versa.

Initial moisture content:

Higher the initial moisture content. The lower the keeping quality and vice versa.

Initial acidity:

Higher the initial acidity, lower the keeping quality and vice versa.

Exposure to metals:

When ghee comes in contact with metals especially iron and copper, its keeping quality gets reduced. Since these is an act as catalytic agents for oxidation.

Exposure to light:

Greater exposure to sunlight causes oxidation of ghee and thus reduces the shelf life.

Method of packaging:

Higher the air-content in the head-space the lower will be the keeping quality

Hydrolytic and Oxidative Deterioration

- Rancidity is the most serious defect of ghee. It is of two types, Hydrolytic and oxidative rancidity. Normally this defect develops in ghee during storage, but if the raw material used for ghee making is rancid, the freshly prepared ghee may have this defect.
- Rancidity in ghee is caused by the formation of volatile compounds, which exhibit unpleasant odours even when present in small quantities. The nutritive value of ghee is adversely affected due to rancidity in ghee.

Hydrolytic Rancidity

The fat-splitting enzyme lipoprotein lipase, found in milk fat globule membrane, is responsible for the hydrolysis of milk fat and the production of lower molecular fatty acids. (Butyric, caproic, and caprylic)

These fatty acids, particularly, butyric impart a rancid flavour to ghee, very high treatment is employed during manufacturing of ghee, which inactivates the lipase enzyme.

Therefore, the hydrolytic rancidity in ghee is not of many problems, provided raw material of good quality is used.

Oxidative Rancidity

Fat oxidation of ghee is amore common problem and is caused by the oxidation of polyunsaturated fatty acids in the presence of oxygen. The reaction of oxygen with poly unsaturated fatty acids involves free radical initiation, propagation, and termination.

Use of good quality raw material for manufacturing ghee. Any off flavour such as acidic, oxidized, and rancid in raw material, shall be carried over to the final product. The raw material should also be checked for copper and iron, which should not be more than permissible limits, which prevents fat oxidation to a large extent.

Antioxidants

Antioxidants are compound that inhibit oxidation, a chemical reaction that can produce free radicals. This can lead to polymerization and other chain reactions.

Ghee is a rich source of vitamins, antioxidants and healthy fats. While fat should be consumed in moderation, studies show that eating fatty foods such as ghee can help the body to absorb some essential vitamins and minerals.

Role of antioxidants in ghee

The choice of antioxidants depends upon the:

- ☞ Specific requirements of the system in which they are used.
- ☞ It should not impart off flavour or colour upon addition or after processing or storage.
- ☞ It easily incorporates in the oil or food products.
- ☞ It readily available at any economic cost.

- Some synthetic antioxidants are: BHA (Butylated Hydroxy Anisole); BHT (Butylated hydroxy toluene); THBQ (Tertiary butyl hydro quinone)
- Some natural antioxidants are: Plant phenols includes flavoured compounds, tocopherol and polyfunctional organic acids.
- α-tocopherol & β carotene are natural antioxidants which occurs in many fats including ghee.
- BHA is legally permitted to a level of 0.01%.

MODULE – 5

Khoa

Introduction

As a versatile intermediate base for a wide range of sweets such as burfi and peda, khoa is prominent in the traditional dairy products sector. Out of India's annual milk production of 209 million tonnes, around 15-20 MT of khoa is producing annually. With a price of ₹250/kg, the khoa market size would be worth ₹65,000 crore.

Product Description

- Khoa is concentrated whole milk product obtained by open pan condensing of milk under atmospheric pressure. It is also known as khoya, khawa, khava, kava, palghoa, or mawa. Khoa contains fairly large quantities of muscle building proteins, bone-forming minerals and energy giving fat and lactose.
- It is also expected to retain large quantities of the fat-soluble vitamins A and D and fairly large quantities of water-soluble B vitamins contained in the original milk. Addition of khoa to sweets further increase the calorific value of the product.

Definition

- According to FSSR 2011, Khoa by whatever variety of names it is sold such as pindi, dhap, Danedar, mawa, or kava means the product obtained from cow or buffalo or goat or sheep milk or milk solids or a combination thereof by rapid drying.
    - The milk fat content shall not be less than 30% on dry weight basis of finished product.
    - It may contain citric acid not more than 0.1% by weight.
    - It shall be free from added starch, sugar, and colouring matter.
- According to BIS, Khoa is a heat coagulated milk product obtained by partial dehydration of buffalo, cow, sheep and goat milk or their admixture. It shall not contain any ingredient foreign to milk except addition of citric acid.

Types of Khoa

There are three distinct varieties ok khoa. They differ in their composition, body and textural characteristics and end use.

1. Pindi
2. Dhap
3. Danedar

Pindi: This variety is identified as a circular ball of hemispherical pat with compact mass, homogenous and smooth texture. It shall not show any sign of fat leakage or presence of free water.

Dhap: It is a raw (Katcha) khoa characterized by loose but smooth texture, soft grains, and a sticky body. This variety of khoa is used in the manufacture of gulabjamun, kalajamun, Pantooa, etc,

Danedar: This is characterized by the granular texture with hard grains of different sizes and shape. Slightly sour milk is preferred in the manufacture of this variety as it yields granular texture.

Chemical Composition

Chemical Composition of khoa

Constituents %	Cow Milk Khoa	Buffalo Milk Khoa
Moisture	30.93	22.34
Total Solids	69.07	77.66
Fat	22.00	32.20
Proteins	19.10	17.70
Lactose	24.10	23.70
Ash	3.72	3.71

Legal Standards

BIS Standards of Khoa

Characteristics	Variety of Khoa		
	Pindi	*Dhap*	*Danedar*
Total Solids % by mass (min)	65.0	60.0	55.0
Fat% by mass (on dry matter)	37.0	37.0	37.0
Total ash (% on dry matter basis)	6.0	6.0	6.0
Titrable acidity % max	0.8	0.9	0.6
Coliform Count/g (max)	90	90	90
Yeast and Mould Count/g (max)	50	50	50

Microbial standards of Khoa as per FSSAI

Characteristics	Quantity
Total Plate Count	Not more than 50000/g
Coliform Count	Not more than 90/g
E. coli	Absent in 1g
Salmonella	Absent in 25g
Yeast and Mould Count	Not more than 250/g
Anaerobic spore count	Absent in 1g
Listeria Monocytogens	Absent in 1g

Physico-Chemical Properties

The changes in Physico chemical properties of milk during khoa making take place due to three actions:

1. Concentration
2. Heating
3. Stirring and Scraping

- **Change of State**

  The removal of moisture from milk results into concentration of milk solids. This eventually changes the state of milk from liquid to soli/semisolid.

  All the constituents including lactic acid **increases** in proportion to the degree of concentration pH **decreases.**

- **Development of cooked flavour**

  Heating of milk causes in proteins resulting in the production of sulphydryl compounds by denaturation of whey protein particularly β-Lactoglobulin.

- **Coagulation of casein**

  Due to the combined action of heat and concentration coagulation of casein tends to increase logarithmically with milk solids concentration and forms a complex with denatured whey protein.

- **Convection of soluble**

  Calcium and phosphate to colloidal form and interaction between protein compounds.

- **Super saturated solution of lactose**

  From a dilute solution in milk, lactose is present in khoa as a super-saturated solution. Most of the **lactose is present as α-hydrate** in khoa.

- **Free fat formation**

  Free fat in khoa is 60% of the total fat in khoa and in cow khoa it is 50% of the total fat. By vigorous stirring and scraping, the fat globule membrane ruptures, thereby releasing considerable amount of free fat in khoa.

  The **water dispenses** as fine droplets in mass of the khoa.

- **Change in colour intensity**

  The colour of khoa becomes intense with brownish tinge due to formation of melanoidins pigment. The browning reactions is maillard type reaction due to interaction between aldose group of lactose and free amino group of casein.

- **Increase in iron content**

  From 2 to 4 ppm iron content in milk, the iron content of khoa increase more than 100 ppm due to the incorporation of additional quantities of iron from the karahi and the khunti by vigorous scraping.

  Water activity of khoa at its normal moisture content observed to be 0.96.

Factors Affecting Quality of Khoa

- Quality of milk
    - Species of Animal
    - Fat Content in Milk
    - Acidity of Milk
    - Presence of additive and adulterants in milk
- Speed of Stirring (optimum speed is 100rpm)
- Temperature of desiccation
- Homogenization of Milk (khoa from homogenized milk shows lower fat leakage and less browning as compared to unhomogenized milk)

Shelf Life

Generally, khoa has shelf life of 2-3 days at room temperature and for a week under refrigerated temperature when packed in parchment paper and paper board box.

It can be stored for longer periods with better packaging and under deep frozen conditions at -18°C or below.

MODULE – 6

Paneer

Introduction

Historically the origin of paneer can be traced to the nomads of southwest Asia who were the first two develop various types of cheese. Among these is the unique Iranian cheese called 'Paneer-Khiki' originally developed by the well-known 'Bhakhtiari' nomadic tribe. When salted it is known as 'Paneer-e-Shour'. The word 'paneer' means container and Khiki means skin.

Product description

Paneer is a heat-acid coagulated milk product obtained by coagulating standardized milk with the permitted acids at specified temperature. The resultant coagulum is filtered and pressed to get the sliceable curd mass. *Paneer* has a firm, close, cohesive and spongy body and smooth texture. It is mainly prepared from buffalo milk and used for large number of culinary dishes.

Though originally it was localized in Northern part of India but now it is preferred almost all parts of the country. *Paneer* is generally sold as blocks or slices; it is also referred as Indian fresh cheese. It is reported that about 5% of the milk produced in India is converted into *paneer* and *paneer* production is growing annually at the rate of 13%.

Definition

Paneer means the product obtained from the cow or buffalo milk or a combination thereof by precipitation with sour milk, lactic acid, or citric acid. It shall not contain more than 70% moisture and milk fat content shall not be less than 50% of the dry matter.

Low fat *paneer* shall contain, not more than 70% moisture and not more than 15% milk fat on dry matter basis.

Legal standards

FSSR-2011 standards for microbial quality of paneer

Total Plate Count	NMT 5,00,000/g
Coliforms	NMT 90/g
E. coli	
Salmonella	Absent in 1g
Staphylococcus aureus	NMT 100/g
Yeast and Mould Count	NMT 250/g
Listeria monocytogens	Absent in 1g

BIS Standards for paneer

Characteristics	Percentage
Moisture, max	60
Milk fat, min	50
Titratable acidity, max	0.5
Total Plate Count	NMT 50,000/g
Coliform Count, per g Max	90
Yeast and Mould per g Max	250

Physico chemical changes during manufacture

The phenomenon of coagulation involves formation of large structural aggregates and network of protein in which milk fat globules gets embedded. Acid and heat treatment causes the physical and chemical changes in casein.

Heating causes interaction of ß-lactoglobulin with κ-casein and the complex formed between ß-lactoglobulin and α-lactalbumin. Acidification initiates the progressive removal of tri-calcium phosphate from the surface of the casein and it gets converted into mono-calcium phosphate.

Further calcium is progressively removed from calcium hydrogen caseinate to form soluble calcium salt and casein. Colloidal dispersion of discrete casein micelles changes into large structural aggregates of casein. Under such a circumstance dispersion is no longer stable, casein gets precipitated and forms coagulum. Fat is embedded in the casein network.

Factors affecting quality and yield of panner

- Type of milk
- Quality of milk
- Type, strength and temperature of coagulant
- Heat treatment of milk
- Coagulation temperature
- pH of coagulation

Physico chemical changes during storage

Paneer is obtained by direct acidification at elevated temperature, its microflora come from cooling water, environmental contamination due to air, equipment, workers and packaging materials. This results in post manufacturing changes in fat and protein integrity of paneer and loss of its moisture.

Packaging materials, sanitary conditions, and storage temperature and period are critical factors in maintaining quality and minimizing microbial, chemical and physical deterioration.

Storage at the ambient temperature for two to three weeks causes the total count to increase rapidly to tens of millions cfu/g. The pH of paneer drops from 5.5 to 4.5 with concomitant separation of visible free moisture in pouches.

Shelf life

This is normally one to two days for the traditionally made product and up to six days for standardized products under refrigerated storage. Vacuum packaging of paneer in laminated pouches increases the shelf life to about 30days at 6℃.

MODULE – 7

Dahi

Introduction

Dahi and yogurt have many things in common. Both have live cultures that nurture therapeutic and health promoting properties, along with proven nutritional benefits. In both, a part of the milk lactose is converted into lactic acid by the action of starter culture.

Product description

Dahi is produced from heat treated milks after inoculation with certain species of lactic acid bacteria added to milk in the form of starter culture. Lactic acid bacteria added multiply, grow and produce lactic acid, acetic acid and carbon dioxide by utilizing lactose present in milk. Some bacteria use citric acid of milk to produce certain volatile organic compounds mainly **diacetyl,** which is mainly responsible for flavour of dahi. Judicious combination of acid producing and flavour producing microorganisms in the starter helps in the production of Dahi with a firm body and good flavour.

Definition

Dahi or curd is a semi solid product, obtained from pasteurized or boiled milk by souring, using harmless lactic acid or other bacterial cultures. Dahi may contain additional cane sugar. It should have the same minimum percentage of fat and solids-not-fat as the milk from which it is prepared.

Chemical composition

Chemical composition of Dahi

Components	Whole milk Dahi	Skim Milk Dahi
Water	85-88	90-91
Fat	5-8	0.05-0.1
Protein	3.2-3.4	3.3-3.5
Lactose	4.6-5.2	4.7-5.3
Lactic acid	0.5-1.1	0.5-1.1
Ash	0.7-0.75	0.7-0.75

Legal standards

FSSR 2011 and BIS standards of Dahi

Characteristics	FSSR 2011	BIS
Acidity %	-	0.6 – 0.8
Total plate count	NMT 1000000/g	-
Coliform count	10 per g max	10 per g max
E. Colli	Absent in 1g	-
Salmonella	Absent in 25g	-
Staphylococcus aureus	NMT 100/g	-
Yeast and Mould	100 per g max	100 per g max
Phosphatase test	-	Negative

Physico chemical changes during manufacture

The following changes take place in milk during conversion of milk to curd:

- During the formation of curd, both specific gravity and total solids are observed to decrease.
- The fall in specific gravity is due to slight expansion in volume on curd formation. Total solid decreases as a result of formation of decomposing products like ammonia, volatile acid and alcohol on fermentation.
- Curd prepared from skim milk differs with that of whole milk in that the former has a little fat, a slightly higher water and lactose content. Lactose in whole buffalo milk seems to ferment faster and to a larger extent than the cow milk.
- There are also considerable changes that occur in the mineral contents of milk during souring at pH 4.6 all the calcium is in ionic form and all the Phosphorus except that conjugated to casein, exist as ionic phosphate.
- Changes in vitamins contain milk on fermentation depending on the type of organism used.

Physico chemical changes during storage

The Physico chemical changes during storage was observed in the decreases in pH value of products.

MODULE – 8

Channa

Product description

Chhana is an acid coagulated product obtained from milk. The curd mass obtained when milk is coagulated with the organic acids such as citric acid, lactic acid at higher temperature and after subsequent drainage of whey, mass of curd obtained is called chhana.

It looks off-white, tastes mildly acidic, and has characteristic spongy texture. Chhana is mainly prepared from cow milk and used for preparation of varieties of Bengali sweets.

About 4 to 4.5% of the total milk produced in India is used for chhana making. Chhana is used as a base for the preparation of a variety of sweets like sandesh, rasogolla, chamcham, rasomalai, pantooa, chhana murki, etc.

Definition

According to FSSR-1511 chhana means the product obtained from the cow or buffalo milk or a combination thereof by precipitation with sour milk, lactic acid or citric acid. It shall not contain more than 70.0 per cent moisture and the milkfat content shall not be less than 50.0 per cent on dry matter. Milk solids may also be used in preparation of this product.

Low fat chhana shall conform to the following requirements: -

- Moisture Not more than 70.0 percent
- Milk fat Not more than 15.0 percent of dry matter

Chemical composition

Constituents	Cow Milk Channa	Buffalo Milk Channa
Moisture	53.4	51.7
Fat	24.8	29.7
Lactose	2.2	2.3
Proteins	17.4	14.4
Ash	2.1	1.9
pH	5.7	5.4

Physico chemical changes during manufacture

- Dairy plants prefer to buy buffalo milk as it contains higher proportion of fat and total solids, approximately 1.5 to 2.0 times fatter than cow milk.
- Because of many inherent differences in Physico-chemical makeup of cow and buffalo milk several problems are encountered during processing of buffalo milk.
- Calcium content has direct correlation with hardness of chhana. The high calcium and casein (cow milk contains 110mg calcium and 2.42 - 2.7% casein and buffalo milk contain 170mg calcium and 2.6 - 3.38% casein per 100g milk) contents in buffalo milk render it unfit for preparation of most chhana based sweets.
- Few attempts have been made to produce chhana from buffalo milk. A mixture of buffalo milk and cow milk in the ratio of 1:3 yields chhana with soft body and smooth texture which is desired feature of chhana for rasogolla and sandesh preparation.
- Addition of mixture of sodium diphosphate (75g per 100lit.) and disodium phosphate (58g per 100lit.) followed by storing the hot milk for some time before precipitation produces a soft chhana. Sodium citrate converts some of the insoluble calcium into soluble salts in buffalo milk and this helps in production of softer chhana.

Factors influencing quality of chhana

- Type of milk
- Quality of milk
- Type, strength and quantity of coagulant
- Temperature and pH of coagulation
- Speed of stirring during coagulation
- Method of straining
- Effect of heat treatment given to milk

Physico chemical changes during storage

Chhana is an extremely perishable due to its high moisture content. At room temperature, it does not keep longer than a day. Under refrigeration, the shelf life can be extended up to six days. Packaging materials used to pack chhana have a role in extending the shelf life. The cow milk and buffalo milk chhana stored in tin cans and cellulose film/LDPE was found acceptable upto 3days at 370C, and 20days at 4-50C. Since fresh chhana is preferred for making sweets of good quality not much research efforts have been made for extending the shelf life

MODULE – 9

Lassi

Introduction

Lassi, similar to butter milk, is a refreshing summer beverage popular in north India. Lassi is a white to creamy white viscous liquid with a sweetish, rich aroma and mild to high acidic taste. It is flavoured either with salt or sugar and other condiments, depending on regional preferences.

Butter milk is a popular refreshing drink prepared from the by-product produced during the preparation of butter/makkhan from dahi. Butter milk is also known as Mattha, Chhachh or Chhas in northern part of India. In south India it is called as Majjige or Majjika.

Product description

Lassi can be described as a fermented milk beverage obtained after the growth of selected lactic acid bacteria in heat treated milk followed by sweetening with sugar. It is consumed as a cold refreshing beverage in summer. It is prepared by breaking the curd in to fine particles by agitation, addition of sugar, water and optionally flavour.

Chemical composition

Chemical composition of Lassi

Components	% In lassi
Fat	1.5 – 3.8
SNF	9
Sugar	13 – 15
Low methoxy pectin	0.5
Acidity	0.7 % min

Physico chemical changes during manufacture

Lassi is becoming popular and attracting demand throughout the year. To meet the consumer, demand many dairies have started producing lassi on commercial scale. Similar to dahi, fresh, good quality milk is essential for production of good quality lassi. Raw milk is standardized for the fat content ranging between 1.5 – 3.8% and 9% SNF.

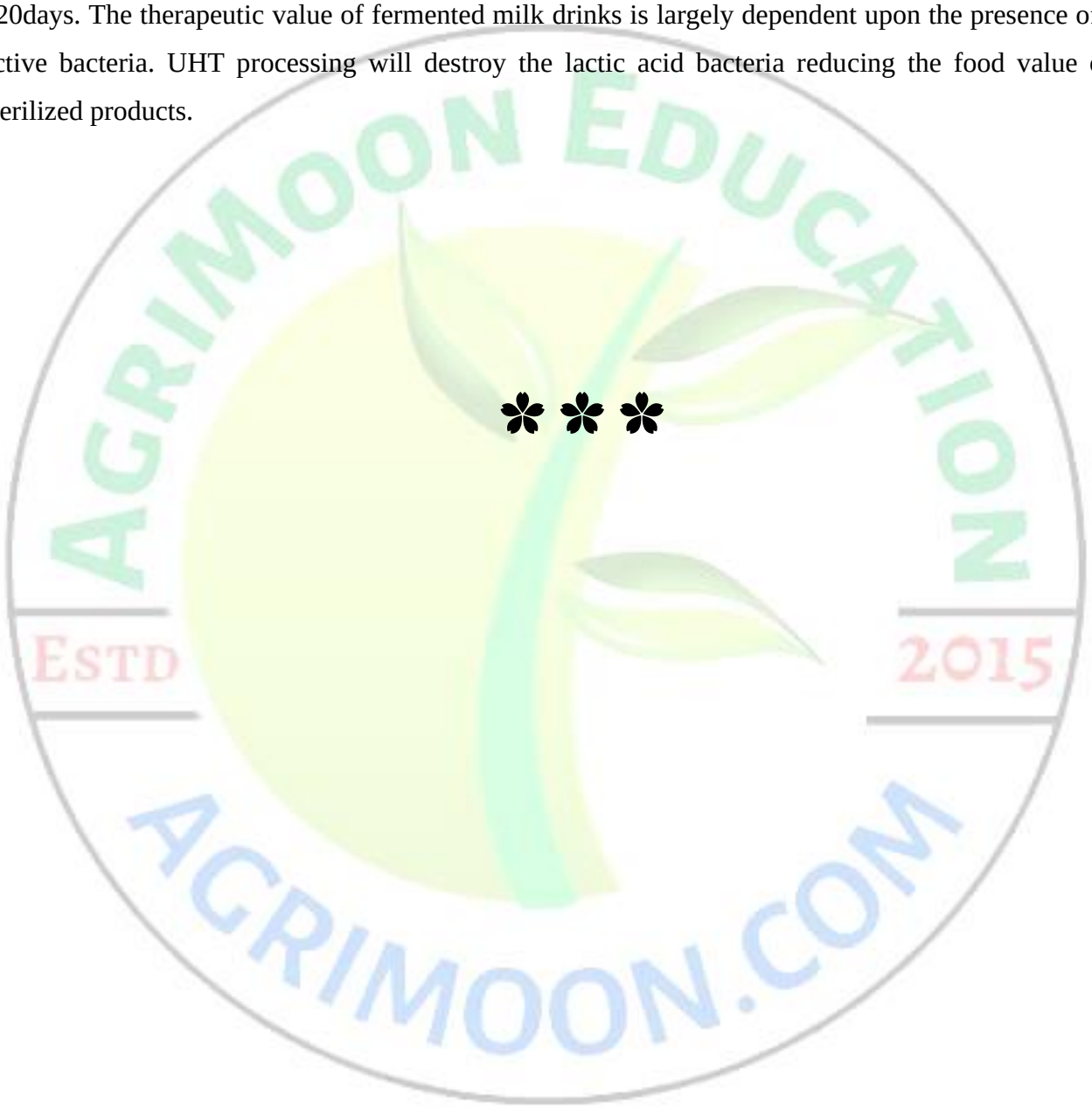
Standardized milk is heated to 90ºC for 15min, cooled to 60ºC and homogenized at 150kg.cm2 and 50kg/cm2 at 1st and 2nd stage respectively. Milk is cooled to 30 -32ºC, inoculated with lactic culture and incubated to attain the pH of 4.5.

The curd is broken with the help of a power-driven agitator. Sugar syrup (25% syrup) is added to the mix to give 12% sugar concentration in the blend.

Low methoxy pectin after making solution in water/syrup can also be added @ 0.5% at this stage as a stabilizer to improve the appearance and mouth feel. The mixture can be flavoured with rose water and homogenized to improve body and texture. It is packed and stored at refrigeration temperature.

Shelf life

Butter milk and lassi packed in LDPE pouch can be stored upto 7days at 5ºC without any significant change in its sensory qualities. Lassi subjected to UHT treatment and packed aseptically has shelf life upto 120days. The therapeutic value of fermented milk drinks is largely dependent upon the presence of live-active bacteria. UHT processing will destroy the lactic acid bacteria reducing the food value of the sterilized products.



MODULE – 10

Chakka

Product description

Chakka is a fermented, intermediate dairy product obtained during the production of Shrikhand. Chakka can be described as strained dahi, in other words it is the curd mass obtained after removing whey from dahi, either through muslin cloth or basket centrifuge. Chakka is the base material for the production of Shrikhand and Shrikhand wadi.

Chemical composition

Constituents	%
Moisture	71-72
Fat	11.5
Proteins	12.5
Lactose	2.5-3.5
Ash	1.0
Acidity	2.1

Legal standards

FSSR and BIS requirement for chakka

Components	FSSR 2011		BIS	
	Skim milk chakka	Whole milk chakka	Skim milk chakka	Whole milk chakka
Total solid (min)	20	30	20	30
Milk fat	5 max	33 min	5 max	33 min
Milk proteins (min)	60	30	60	37
Acidity (max)	2.5	2.5	2.5	2.5
Ash (max)	5.0	3.5	5.0	3.5
SPC	Max 50,000			-
Coliform (max)	10	10	10	10
Yeast and mould (max)	10	20	20	20

MODULE – 11

Shrikhand

Introduction

Shrikhand is a semisolid sweetish-sour fermented milk product prepared from the dahi. Whey is drained off from the dahi to yield chakka. Sugar, flavour, colour, and spices are thoroughly mixed into chakka to form a soft homogeneous mass that resembles sweetened quarg of Germany.

Product description

Shrikhand is a popular fermented, sweetened, indigenous dairy product having semi solid consistency with typical sweetish-sour taste. It is very popular in the state of Gujarat, Maharashtra and part of Karnataka. It is prepared by mixing chakka with sugar, color, flavour, spices and other ingredients like fruit pulp, nuts etc. to form soft homogenous mass.

Chemical composition

Constituents	%
Moisture	35-40
Fat	8.5-9.0
Proteins	9.5-12.5
Lactose	2.5-3.5
Sucrose	70-74
Ash	0.6-0.5
Acidity	1.0-1.3
pH	4.3-4.1

Legal standards

FSSR/BIS standards of Shrikhand

Particulars	BIS	FSSR
Total solids %by mass min	58	58
Milk fat %DM min	8.5	8.5
Milk protein %DM min	10.5	9.0
Acidity max	1.4	1.4
Sucrose %DM max	72.5	72.5
Ash %DM max	0.9	0.9
Coliform count cfu/g max	10	10
Yeast and mould cfu/g max	50	50

Shelf life

Due to both high acid and sugar levels, Shrikhand has a fairly long shelf-life of 30-40 days at 8°C and 2-3 days at 30°C.

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MODULE – 12

Cheese

Introduction

Cheese is one of the oldest foods of mankind. It is believed that cheese evolved in the Fertile Crescent between the rivers Tigris and Euphrates in Iraq. Cheese was a prominent item of the Greek and Roman diet. The annual growth rate in cheese consumption being over 3%. About 40% of total world milk production is converted into cheese.

Product Description

The word cheese is derived from the old English word 'cese' which in turn was derived from the Latin 'caseus' which means correct or perfect thing.

Cheese is the curd or substance formed by the coagulation of the milk of certain mammals by rennet or similar enzymes in the presence of lactic acid produced by added or adventitious micro-organism, from which part of the moisture has been removed by cutting, warming and / or pressing, which has been shaped in a mould and then ripened by holding for some time at suitable temperature and humidities.

Definition

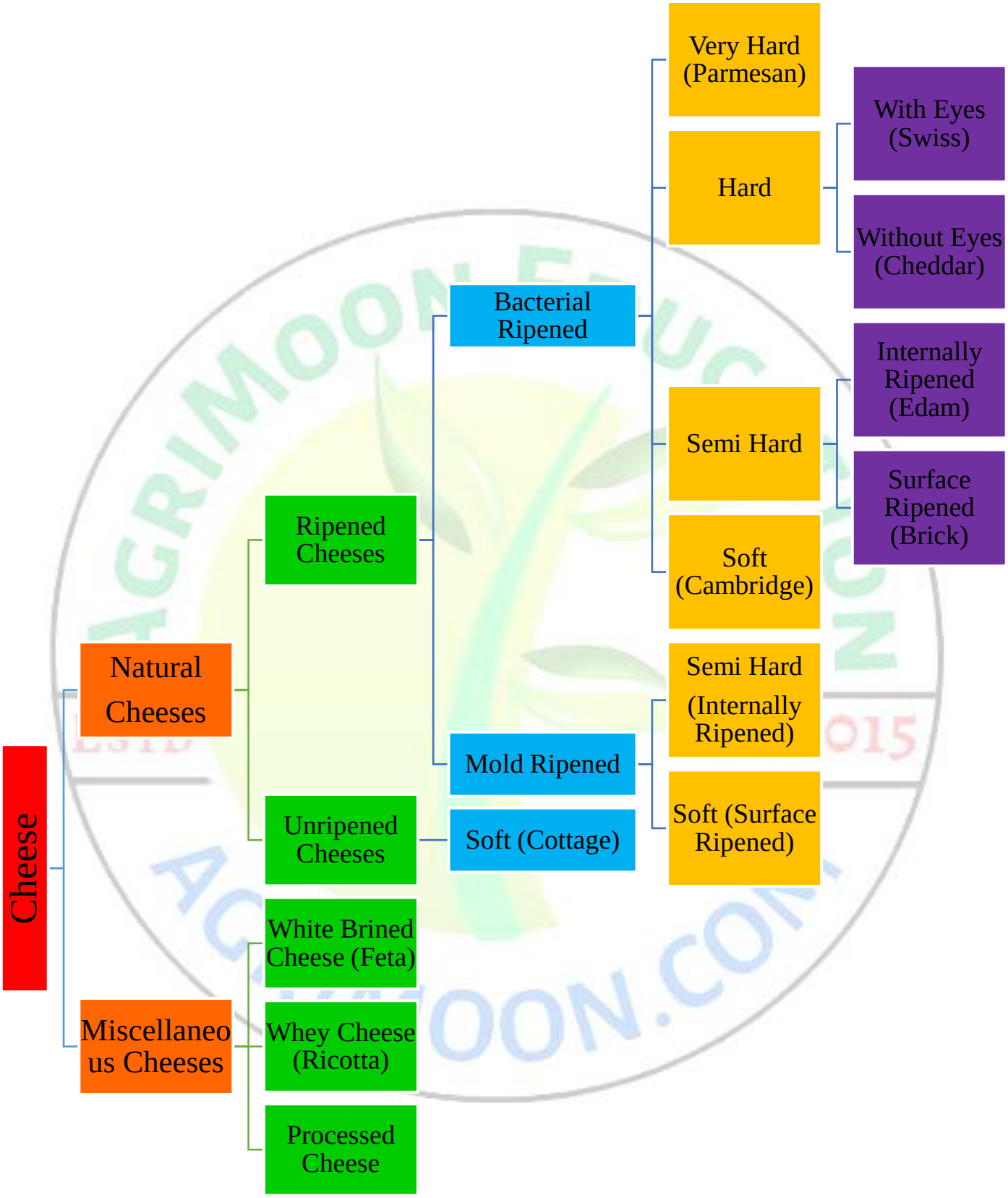
According to the PFA Rules, cheese means the product obtained by draining after the coagulation of milk with a harmless milk coagulating agent, under the influence of harmless bacterial cultures. It shall not contain any ingredients not found in milk, except coagulating agent not exceeding 0.02 percent by weight.

According to 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 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 which give the final product.

Types of Cheese

Cheeses are highly diversified. There are about 2000, varieties of cheese are known. This wide variety is divided into following categories:


Cheese
Natural Cheeses
Miscellaneous Cheeses
Ripened Cheeses
Unripened Cheeses
White Brined Cheese (Feta)
Whey Cheese (Ricotta)
Processed Cheese
Bacterial Ripened
Mold Ripened
Soft (Cottage)
Very Hard (Parmesan)
Hard
Semi Hard
Soft (Cambridge)
With Eyes (Swiss)
Without Eyes (Cheddar)
Internally Ripened (Edam)
Surface Ripened (Brick)
Semi Hard (Internally Ripened)
Soft (Surface Ripened)

Composition of Cheese

Approximate composition of some varieties of cheese

Variety	Moisture	Fat	Protein	Ash	Salt
Cheddar	37.5	32.0	25.0	2.0	1.5
Gouda	38.5	28.5	25.5	2.5	1.5
Swiss	39.0	28.0	27.0	2.0	1.5
Mozzarella	54.0	18.0	22.1	2.3	0.7
Cottage	79.5	0.3	15.0	0.8	1.0

Legal Standards

Legal standards for cheese

Type of Cheese	Moisture, Maximum	Milk Fat (FDM), Min
Hard pressed cheese	39%	48%
Semi hard cheese	45%	40%
Semi soft cheese	52%	45%
Soft cheese	80%	20%
Extra hard cheese	36%	32%
Mozzarella cheese	60%	35%
Pizza cheese	54%	35%

Milk Clotting Enzymes

Milk coagulation is a basic step in cheese manufacturing. Calf rennet, the conventional milk clotting enzyme obtained from the fourth stomach of suckling calves was the most widely used coagulant in cheese making all over the world to manufacture most of the cheeses.

Milk clotting enzyme from plants

Enzymes from many plant sources may be used as clotting enzymes in cheese making but most of the plant proteases are strongly proteolytic and cause extensive digestion of the curd, resulting in reduced yields, bitter flavour and pasty-bodied cheese.

Some plant enzymes are: *Papain, Ficin, Bromelain,* enzyme extracted from *Withania Coagulans.*

Microbial Rennet

A large number of microorganisms are known to produce milk clotting enzymes. Microbial enzymes are known to exhibit considerable variations in the range of activity. Milk clotting enzyme from bacteria like *streptococcus liquefaciens, Bacillus cereus* have been used as coagulating enzymes. Milk clotting enzymes from fungi are also used during cheese making.

Enzymatic coagulation of milk

The enzymatic coagulation of milk is essentially a two-stage process. The casein micelle is stabilized by ƙ-casein layer on the surface of the micelle. The enzymes present in rennet hydrolyse ƙ-casein layer to form paracasein micelles which aggregate in presence of calcium and thus milk is coagulated.

The hydrolysis of the ƙ-casein as the primary phase of rennet coagulation while the aggregation of paracasein micelles in presence of calcium is called secondary phase of rennet coagulation of milk.

The amino acid chain forming the ƙ-casein molecule consists of 169 amino acids. Rennet enzymes act specifically at 105-106 bond of this amino acid, thereby splitting it into two parts. One part consists of amino acids from 1-105, called as para-ƙ-casein. This part is insoluble and remains in curd together with αs and β-casein. The other part of amino acids from 105-169 is soluble part.

Ripening of cheese

Ripening also referred to as curing, maturing, or ageing. *Ripening of cheese* is process of storage of fresh cheese curd at suitable temperature till it transforms into a finished product of desirable body, texture and flavour.

The ripening of cheese is a slow and consequently an expensive process as it involves heavy expenditure on refrigeration and labour apart from resulting in loss of product due to microbial damage. Attempts are being made to reduce ripening period by accelerating the bio-chemical changes.

Cheese is ripened at elevated temperature i.e., at 15°-20°C for about 2-3 weeks depending upon the required flavor intensity and on the type of cheese before transferring to traditional normal temperature of ripening.

Biochemical changes during ripening

Unique characteristics of cheese variety is determined by the curd manufacturing operations but these characteristics are largely developed during ripening process. Ripening involves microbial and chemical changes which are responsible for development of typical characteristics of varieties of cheeses. Microbial changes involve death and lysis of the starter cells, development of non-starter microflora and growth of secondary microflora.

Ripening usually causes softening cheese texture due to hydrolysis of the casein matrix, changes in pH and change in water binding ability of the curd. Flavour production is largely described by a series of biochemical events taking place during ripening.

The primary events occurring during cheese ripening are metabolism of residual lactose, lactate metabolism, proteolysis and lipolysis. These reactions are mainly responsible for textural changes and

development of flavour in cheese. Secondary changes occur simultaneously and modify cheese texture and flavour.

Metabolism of Residual Lactose

Lactic acid bacteria (LAB) are added in the form of starter culture to cheese metabolize lactose to lactate. The rate and extent of acidification influence texture of the curd by controlling the rate of demineralization. pH influences the solubility of the casein which affect the texture of curd. It also affects the activity of enzymes involved in ripening, thereby having an indirect effect on cheese texture and flavour development.

Most of the lactose is lost in whey during cheese manufacturing. However, low level of lactose remains in the curd. This residual lactose is converted to L-lactate during early stages of ripening by the action of starter bacteria.

Starter activity is stopped very quickly at the end of manufacturing operations due to low pH, salt addition and lesser amount of fermentable lactose.

Lactate Metabolism

Lactate produced by fermentation of residual lactose serves as an important substrate for a range of reactions occurring during cheese ripening. Lactose can be metabolized to acetate, ethanol, formate and CO_2 depending on the population of NSLAB and availability of O_2.

Late gas blowing defect which is caused by anaerobic metabolism of lactate by ***Clostridium tyrobutyricum*** to butyrate and H_2. The release of H_2 causes cracks in cheese during ripening. The above-mentioned metabolism contributes negatively towards cheese ripening but there are some positive contributions also of lactate metabolism.

Propionibacterium freudenrichii metabolise lactate to propionate, acetate, CO_2, and H_2O. propionate and acetate contribute to the flavour of cheese while CO_2 is mainly responsible for eye formation.

Lipolysis

Milk fat is also essential for the development of the correct flavour in cheese ripening. Lipids may undergo oxidative or hydrolytic degradation in foods but the redox potential of cheese is very low, so mainly hydrolytic degradation of lipids takes place in cheese.

The triglycerides present in cheese are hydrolyzed by lipases which result in the formation of fatty acids. Low level of lipolysis is required for the development of flavour of cheese but excessive lipolysis cause rancidity.

Lipolysis of milk fat results in production of free fatty acids which contribute to the flavour of cheese and also act as precursors for the development of the other flavour compounds in cheese like esters, lactones, ketones and aldehydes.

Proteolysis

Proteolysis is the most important and complex of all the events during ripening of cheese. The extent and pattern of proteolysis is also used as an index of cheese ripening and quality of cheese.

Proteolysis contributes significantly towards development of texture and flavour in cheese. Textural changes (softening of cheese curd) occur due to breakdown of protein network and release of carboxyl and amino groups resulting in the binding of more water and thus decreases water activity (aw).

Proteolysis leads to the formation of peptides and free amino acids which contribute to cheese flavour. These amino acids also act as precursors for many reactions like transamination, deamination, decarboxylation, desulphuration.

MODULE – 13
Condensed Milk

Introduction

Condensed milk means the product obtained from cow or buffalo milk or a combination thereof or from standardized milk by the partial removal of water and after addition of cane sugar. It may contain added refined lactose, calcium chloride, citric acid and sodium citrate, sodium salts of orthophosphoric acid and poly-phosphoric acid (as linear phosphate) not exceeding 0.3 percent by weight of the finished product. Such addition need not be declared on the label. Sweetened Condensed milk shall contain not less than 9.0 percent milk fat, not less than 31.0 percent total milk solids and not less than 40.0 per cent cane sugar. The total acidity expressed as lactic acid shall not be more than 0.35 percent.

Evaporated milk means the product obtained from cow or buffalo milk or a combination thereof or from standardized milk by the partial removal of water. It may contain added calcium chloride, citric acid and sodium citrate, sodium salts of ortho-phosphoric acid and polyphosphoric acid (as linear phosphate) not exceeding 0.3 percent by weight of the finished product. Such additions need not be declared on the label. Unsweetened Condensed milk shall contain not less than 8.0 percent milk fat and not less than 26.0 percent milk solids. The product shall be suitably sterilized. If the product is subjected to Ultra High temperature (UHT) treatment by heating it to a temperature of not less than 140°C for a minimum period of 3 seconds followed by aseptic packaging it shall be designated as UHT and labelled.

Definition

"Condensed milks are a product obtained by evaporating part of water from whole milk or fully or partly skimmed milk." The term condensed milk is commonly used when referring to full cream sweetened condensed milk

According to FSSAI, Condensed milk means the product obtained by partial removal of water from milk with addition of sugar or a combination of sucrose with other sugars or by other process which leads to a product of the same composition and characteristics. It shall be free from any substance foreign to milk. It may contain food additives permitted in the regulations including Appendix A.

Legal standards

Legal Standards of condensed milk according to FSSAI

Characteristics	Sweetened Condensed Milk	Sweetened Condensed Skim Milk
Total milk solids, min	31	26
Fat	Not less than 9	Not more than 0.5
Sucrose, min	40	40
Acidity, max	0.35	0.35
Bacterial count per gm, max	500	500
Coliform count per gm	Negative	Negative
Yeast and mould per gm, max	10	10

Legal Standards of evaporated milk according to FSSAI

Characteristics	Evaporated milk	Evaporated Skimmed Milk
Total milk solids, min	31	26
Fat	Not less than 9	Not more than 0.5
Sucrose, min	-	-
Acidity, max	0.30	0.30
Bacterial count per gm, max	-	-
Coliform count per gm	-	-
Yeast and mould count per gm, max	-	-

Physico chemical properties

During the manufacture of condensed milk certain physical changes such as development of brown colour, changes in viscosity are noticed besides increase in density/specific gravity. One of the important chemical changes noticed is decrease in pH. These changes occurring in the Physico-chemical properties in condensed milk due to various processing conditions have profound effect on the final quality and self-life and storage stability of the product.

Some of these Physico-chemical properties are discussed below:

a. Density/ Specific Gravity
b. Freezing Point
c. Colour and Flavour
d. Viscosity

e. Changes in pH

Density/Specific Gravity:

- Removal of water in the manufacture of condensed milk increases the total solids content.
- Because of the increase in total solids concentration the density/sp. gr. Of condensed milk increases.

Freezing Point:

- Freezing point of milk is quite constant; however, it is always lower than that of water and varies with composition of milk.
- Removal of water as well as addition of soluble substances, such as sugar, has direct effect on the freezing point of condensed milk.

Viscosity:

- Viscosity of condensed milk varies greatly according to the composition, processing conditions and storage period.
- Increase in concentration increases the viscosity.
- Homogenization and low temperature storage also contribute to the increase in viscosity.
- Viscosity during the manufacture and storage of concentrated milk is highly important for successful marketing of the product.
- Too high or low viscosity is not desirable in the product.
- Low viscosity tends to leave objectionable sugar sediment in condensed milk and fat separation in evaporated milk.
- Too high viscosity causes gel formation and mineral deposits in evaporated milk.

The viscosity of condensed milks seems to be influenced by the following factors:

i. Concentration
ii. Composition
iii. State of protein and fat
iv. pH and salt-balance
v. Temperature of fore-warming/pre-heating

Colour and Flavour:

- Objectionable brown colour is sometimes found in condensed milks.
- Exposure to high heat during manufacture and storage of condensed milks tends to darken their colour and develop a “cooked” flavour.

Changes in pH:

- A decrease in pH as compared to milk can be expected in condensed milks during manufacture because of the processing steps such as preheating, concentration and sterilization.
- Decrease in pH has definite effect on the stability of concentrated milk towards heat sterilization.

Physico chemical changes during storage

Condensed milk and evaporated milk are the products suitable for prolonged storage. They have typical properties after production by which they are identified. These properties must be such that the product is fit for sale immediately after production and does not alter during reasonable period of storage.

They should, therefore be physically, chemically and bacteriologically fit for human consumption by the end of storage period. Routine examination of the product soon after manufacture as well as during storage may be carried out to judge the quality of the product. If any defect is noticed, proper care should be taken to climate the defect in the subsequent batches. It is, therefore, important to know what type of defects may occur in the product, the reasons for their occurrence and the preventive measures to be used to avoid these defects.

Heat Stability of Condensed Milk and its Control

- The heat stability of milk is of tremendous importance in the successful processing of milk and the manufacture of most dairy products.
- The application of heat to milk becomes necessary for the destruction of spore resistant micro-organism and the preservation of the most desirable product characteristics.
- *"Heat Stability of milk may be defined in terms of the time required to induce coagulation at a given temperature, such as 115°C."*

  Alternatively, *"the term 'heat stability' of evaporated milk refers to the relative resistance of the milk to coagulation in the sterilizer."*
- The coagulation of milk revolves around the coagulation of milk proteins. Milk proteins namely casein and whey protein which represents 82% and 18% of the total quantity respectively. Casein exists in milk as complex colloidal particles or miscelles containing calcium, magnesium, phosphate and citrate in addition to casein proteins. This system is generally referred to as the calcium-caseinate-phosphate complex.

Microbial/Non-Microbial defects in Condensed Milk

1. Gassy fermentation
2. Bacterial thickening
3. Mould buttons
4. Sandiness
5. Age thickening
6. Fat separation
7. Brown colour

Evaporated milk is sterilized product. If sterilization is properly carried out the product will remain in good condition without any bacterial spoilage during storage. However, if sterilization process is improperly carried out, some microorganisms and spore may, survive and cause spoilage, during storage, Gassy fermentation, coagulation, bitterness and fishy flavour are some of the defects noticed in improperly sterilized evaporated milk. If the bacterial defect in evaporated milk is to be eliminated, it is essential that the sterilization process should be carried properly and adequately with strict cleanliness in the factory.

Chemical/Physical defects in Evaporated Milk

1. Age thickening
2. Age thinning
3. Fat separation
4. Sediments/mineral deposit
5. Brown colouration

MODULE – 14

Dried Milk

Introduction

Dehydration or drying is one of the simplest methods of preserving extremely perishable food and conversion of surplus milk into dried powder with a moisture content low enough as not to promote bacterial growth and deterioration of quality during long storage.

The dried milk and milk products can be reconstituted to supplement the short supplies of milk during the lean season of the year and in places where fluid milk is in short supply.

Today, the production of dried milk and milk product has become an increasingly important segment of the dairy industry. Dry milk provides a means of handling the excess milk supply in a dairy factory during the flush season while in the lean season that meant for the production of dry milk can be diverted to market milk. Thus, dry milk may be called the balance wheel of the dairy industry today. In India, the first ever commercial production of spray dried milk was started by Amul dairy, Anand in 1955.

Definition

Dried milk or milk powder is the product obtained by the removal of water from milk by heat or other suitable means, to produce a solid containing 5% or less moisture. The dried product obtained from whole milk is called dried whole milk or whole milk powder (WMP) and that from a skim milk is known as dried skim milk or skim milk powder (SMP) or Non-fat dry milk (NFDM).

The objective or purpose of drying milk are following:

a) To remove the moisture so as to reduce bulk
b) Reduce the cost of transportation
c) Improve the storage life of the product
d) Provide a product which can be utilized for many foods manufacturing operations
e) To conserve as far as possible the natural properties of the original raw material

Legal standards

Legal Standards according to BIS

Characteristics	WMP	SMP
Total milk solids, min	96.0	95.0
Fat	Not less than 26	Not more than 1.5
Moisture, max	4	5
Acidity, max	1.2	1.5
Bacterial count per gm, max	50,000	50,000
Coliform count per gm	90	90

Total Ash, max	7.3	9.3

Physico chemical properties

Good-quality dried milk should flow readily, be free from lumps or caking and be uniformly white or light cream in colour. Several properties of powdered products affect the quality and the suitability of the powder in specific applications. The physical properties of the powder may confer different properties upon powders of identical chemical composition.

Particles shape

Dried milk is found to be round with different surface structures, as revealed by electron microscopy. Some particle may be smooth, but most of them are severely wrinkled with deep surface folds and having "apple-like structure" caused by an implosion during the last stage of drying process or during the cooling of particles.

Particle size distribution

Particle size is of importance for the reconstitution of powder, its flowability and appearance. Particle size distributions of milk powder are usually between 20 and 60 μ m, and the distribution is relatively wide.

The particle size distribution of a milk powder depends on a number of factors in the production process. These are:

(a) Speed of rotation or pressure applied

(b) Feed rate of the concentrate

(c) Velocity of concentrate through the orifice (in case of nozzle type atomizer)

(d) Feed concentration and its viscosity.

(e) Temperature difference between the drying droplet and the hot air in the drier

Effect of atomizers

With a given liquid, pressure-jet atomizers tend to produce the lowest air-cell volume and the highest proportion of solid particles. On the other hand, air cell volume is also closely related to the concentration of the liquid being sprayed, and thus pre-concentration of the milk to a high solids content give less trapped air in the powder.

Status of lactose

Lactose is the major constituent of the particle itself and comprises about 38 % of full cream powder and 50% of separated milk powder. It forms an amorphous glass-like envelop entrained in the particle and is

also in the continuous phase within it. The outer envelope is only and slightly permeable and retains enclosed air and gases and seals in the fat which is only partially extractable by solvents.

Free-Fat

The proportion of free fat is very variable and it is stated to range from 3% to 10% in spray dried milk as compared with 43% to 75% in freeze dried milk and about 90 % in roller-dried milk.

Moisture

The moisture content of a milk powder is defined as that part of the water contained by the solid which is in a form capable of taking part in deterioration of the powder. Thus, water which is bound in the lactose crystal is not normally considered to be part of the moisture content of milk powder.

The moisture content of a powder is estimated by

(a) Oven drying at 102°C ± 2°C to constant weight.

(b) Toluene distillation method

(c) Karl Fischer titration method.

Bulk Density

The density of a powder may be defined in various ways. The density of the particle material, i.e., excluding the vacuoles, is called the true density . The weight of powder which can be packed into a given volume - known as the bulk, apparent, or packing density can vary considerably. Bulk density is important economically, commercially and functionally because it affects the size of containers, storage space and transport space.

Lump Formation

Spray powder may contain small hard lumps when some of the milk droplets are only partially dried.

Flowability

The flowability of a powder refers to the ease with which the powder particles move with respect to one another. This is an important but complex property.

Physico chemical changes during storage

During a storage several defects appear in flavour colour and solubility of the Powder. Stale musty flavour occurs in powder during extended storage. This is promoted by high moisture content and high storage temperature. These are caused by lactose protein changes. Lactose protein reaction causes Browning called maillard reaction.

Fat decomposition in whole milk powder during a storage is due to oxidative or hydrolytic action on milk fat.

MODULE – 15

Ice-Cream and Frozen Deserts

Introduction

Ice cream is a frozen dairy product made by suitable blending and processing of cream and other milk products, together with sugar and flavour, with or without stabilizer or colour, and with the incorporation of air during the freezing process.

Definition

According to the FSSA (2006), Ice Cream, Kulfi, Chocolate Ice Cream or Softy Ice Cream (here after referred to as the said product) means the product obtained by freezing a pasteurized mix prepared from milk and /or other products derived from milk with or without the addition of nutritive sweetening agents, fruit and fruit products, eggs and egg products, coffee, cocoa, chocolate, condiments, spices, ginger and nuts and it may also contain bakery products such as cake or cookies as a separate layer and/or coating. The said product may be frozen hard or frozen to a soft consistency; the said product shall have pleasant taste and smell free from off flavour and rancidity; the said product may contain food additives permitted in this regulation including Appendix A; the said product shall conform to the microbiological requirements specified in Appendix B; the said product shall conform to the following requirements by FSSR.

Legal standards

FSSAI Standards for Ice cream

Requirement	High Fat Ice cream	Medium Fat Ice cream	Low Fat Ice cream
Total solids	NLT 36%	NLT 30%	NLT 26%
Wt./vol	NLT 525	NLT 475	NLT 475
Milk fat	NLT 10%	MT 2.5 but LT 10	NMT 2.5
Milk protein	NLT 3.5	NLT 3.5	NLT 3.0

NLT: not less than; NMT: not more than; LT: less than; MT: more than

Physico chemical changes during processing

Effect of stabilizers

- During the freezing process, as more and more water freezes, the stabilizer and its complexes get concentrated, and these also provide strength to the air cell wall. Therefore, the amount of air which is incorporated and the degree to which the air cells are stable is influenced by stabilizers.

Effect of emulsifiers

- Emulsifiers which are used in ice cream are usually integrated with the stabilizers in proprietary blends, but their function and action is very different from the stabilizers.
- They are used for improvement of the whipping quality of the mix, for production of a drier ice cream to facilitate molding, fancy extrusion, and sandwich manufacture, for smoother body and texture in the finished product.

Effect of Pasteurization

- High temperature in enhance whipping
- due to heat treatment the emulsifier is melted and heat activated stabilizers brought into colloidal solution
- The whey proteins begin to act as emulsifier
- The whey protein present in SNF are partially denatured and uncoil exposing lipophilic proportion of the molecule
- Denaturation also increases the number of available binding sites for protein
- Enhances action of a stabilizer such as carrageenan

Effect of homogenization

- Production of a smoother more uniform product greater apparent richness and palatability and better wiping ability
- Decreases the danger of churning of fat in the freezer
- Shortens ageing period
- It increases the surface tension of the mix
- The amount of water existing as ice in ice cream varies with temperature but it is 50% at an extension temperature – 5 degrees Celsius.

Effect of ageing

- 70% at a storage temperature -11°C
- allows for the hydration of milk proteins and stabilizers
- emulsifiers induced disruption of protein continues
- substantial crystallization of fat occurs
- the appropriate ratio of solid: liquid fat must be attained at this stage which depends on the temp and the triglycerides composition of fat.
- Emulsifiers generally displace milk protein during ageing.
- The whipping qualities of the mix are usually improved with ageing

Effect of freezing process

- Freeze a portion of the water of the mix and to incorporate air of the mix.
- Size of air cells vary from 30-150um and in continues freezer air cell dimeter range from 5 to 300um
- Large air cells produce a smooth texture.

Whipping ability

- It refers to those properties which determines the rate of air incorporation.
- It influenced by composition of mix amount source quality of fat, MSNF
- Way of processing.

Physico chemical changes during storage

- The descriptor, "lacks freshness" or "stale" refers to a moderate off-flavour of ice cream and related frozen desserts. This flavour defect is generally assumed to result from either a general flavour deterioration of the mix during storage, or from the use of one or more marginal quality dairy ingredients in mix formulation.
- For instance, some old milk or old cream, or stale milk powder (non-fat milk solids), may have been incorporated as an ingredient. If the off-flavour imparted by the "marginal" ingredients were quite intense, then "old ingredient" would probably be the most appropriate criticism.
- The "storage" off-flavour generally refers to flavour that may develop either in the mix or in the frozen ice cream (or low-fat ice cream) during the storage period. When ice cream is stored for an extended period of time, the flavour loses its initial lustre, even though no specific defects seem to stand out.

Stabilizers

Stabilizers influence the movement of water, partly due to their ability to form H-bonds and partly due to their ability to form a three-dimensional network throughout the liquid which leads to the immobilization of water. The water binding / immobilizing effect improves the storage stability of ice cream. Furthermore, stabilizers have positive influence on body and texture of ice cream. Finally, stabilizers contribute to the melting resistance of ice cream and prevent wheying off during melting.

Role of stabilizers

- To increase the viscosity of the mix
- To stabilize the mix i.e., to prevent wheying off
- To help in suspension of flavouring particles
- To help prevent shrinkage of the product volume during storage
- To provide uniformity to the product and resistance to melting
- To produce smoothness in texture during consumption
- Reduce the rate of meltdown (i.e., the rate at which ice cream melts)

- Prevent shrinkage and slow down moisture migration out of ice

Mechanism of stabilizers

- Capable of imbibing large quantities of water while still remaining dispersed in water and forming colloidal solutions, stabilizers are functionally also termed as hydrocolloids.
- These vasogenic compounds are primarily polysaccharides although, gelatine a well-known stabilizer is a protein in nature.
- The most apparent effect of stabilizers is the increased viscosity of the continuous liquid phase. The effect of stabilizers on viscosity exhibits considerable interaction with milk constituents.
- For instance, the basic viscosity of stabilizer solution is generally not affected by heat treatment in the absence of milk solids, but in their presence, within creasing total solids, the effect of stabilizer on heat induced increase in viscosity of the system becomes more pronounced.
- Certain stabilizers such as guar gum are effective thickening agents with no gelling ability. Further, the way stabilizers influence the body and texture perception in frozen ice cream could be related to their molecular structure and orientation besides their gel forming or viscosity building ability.

Emulsifiers

Emulsifiers are by definition substances which make the formation of an emulsion possible due to their ability to reduce surface tension

Role of emulsifiers

- Promote nucleation of fat during aging thus reducing aging time
- Improve the whipping ability of the mix
- Produce a dry and stiff ice cream as they enhance fat destabilization,
- facilitating molding, fancy
- extrusion and sandwich manufacture
- Increase resistance to shrinkage and rapid melt down
- Increase resistance to the development of coarse/icy texture
- Provide smooth texture in the finished product

Mechanism of emulsifiers

- The two-phase emulsion is stabilized by casein micelles adsorbed at the fat globule serum interface in the homogenized ice cream mix. But when an emulsifier such as a monoglycerides used, the fat globules are covered with an emulsifier layer and the milk proteins form an outer layer.
- Monoglycerides effectively compete with protein if they form crystals at the interface. Hence, the outer protein layer tends to be repelled from the fat globules. As a result, the emulsion is prone to destabilization by mechanical action during freezing.

- This destabilizing effect, in conjunction with other processing factors, is considered to be primarily responsible for development of the desired product structure.
- The dry appearance of ice cream coming out of the freezer is believed to be caused by several phenomena, one of which is an emulsifier induced clustering of fat globules at the liquid air interface.
- The de-emulsification effect of emulsifiers is related not only to the quantity of emulsifiers used but also to the fat content of the product.
- With increasing emulsifier concentration, fat de-emulsification is enhanced and beyond a certain limit, greasy texture and short body result due to butter formation in the freezer.

MODULE – 16

Important Points

- Metallic flavour is usually due to copper as contaminant in SCM.
- According to FSSAI, 3% free fatty acid maximum as oleic acid present in ghee.
- Addition of calcium chloride and magnesium chloride results in hard body Chhana.
- Buffalo milk has high curd tension than cow milk.
- During working of butter, free fat increases and globular fat decreases.
- 0.2 is water activity for milk powder.
- Not more than 4 should be the percent moisture in whole milk powder as per FSSAI.
- Not more than 5 should be the percent moisture in skim milk powder as per FSSR.
- Butter contains 3-5% air by volume.
- Phytosterol acetate test is done in ghee to detect presence of vegetable fat.
- The temperature of cream when adding neutralizer should preferably be 29 to 32° c.
- The characteristics colour of buffalo ghee is due to bilirubin and biliverdin.
- Cream acidity should be reduced to 0.06 to 0.08 percent before churning into butter for long storage.
- Baudouin test should be negative in ghee.
- If size of crystalline fat is bigger than 0.1 micron in free fat then it is called Mealy texture
- Coagulation temperature of 70 degree Celsius has been suggested to be most effective for good quality of paneer.
- Optimum pH of coagulation is 5.35 for buffalo milk for paneer preparation.
- Optimum pH of coagulation is 5 for cow milk for paneer preparation.
- The hardness of channa is directly related to the calcium content of milk.
- Cow milk is most suitable for preparation of Chhana.
- Buffalo milk is most suitable for preparation of paneer.
- Channa or paneer should contain milk fat NLT 50 % of dry matter FSSR.
- Low fat channa or paneer should contain milk fat NMT 15 % of dry matter FSSR.
- As per FSSR specification khoa should contain not less than 30% milk fat on dry matter basis of finish product.
- Diacetyl content in butter should be not more than 4 PPM.
- Carotenoids content of cow is 3.2 - 7.4 ug/g.
- The RM value of ghee varies from 26-32.
- The Polenske value of ghee should not be more than 2.
- The RM value reflects the amount of caproic & capric fatty acids in milk fat.
- The Polenske value reflect the amount of caprylic, capric and lauric fatty acids in milk fat.

- Preferable temperature to store ghee is below 20°C.
- Sweet curd should not have more than 0.7% acidity.
- 60-100 um mean air cell diameter is satisfactory in ice cream.
- Overall mean size of ice crystals in ice cream is 35-40 um.
- Spray dried milk powder size varies from 10-150.
- Below 93.5 °C, the lactose exists in alpha monohydrate form.
- Above 93.5 °C, the lactose exists in beta monohydrate form.