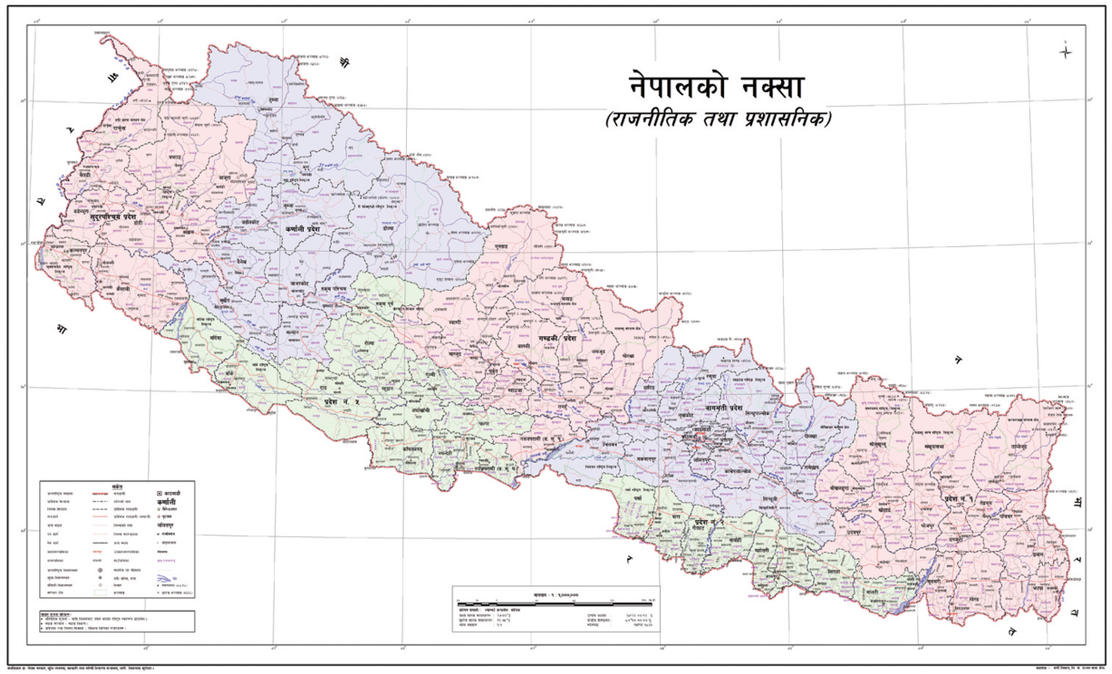

Dairy and Dairy Products

Government of Nepal
Ministry of Education, Science and Technology
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Technical and Vocational Stream
Learning Resource Material

Dairy and Dairy Products

(Grade 10)

Secondary Level
Animal Science

Government of Nepal
Ministry of Education, Science and Technology
Curriculum Development Centre
Sanothimi, Bhaktapur

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Preface

The curriculum and curricular materials have been developed and revised on a regular basis with the aim of making education objective-oriented, practical, relevant and job oriented. It is necessary to instill the feelings of nationalism, national integrity and democratic spirit in students and equip them with morality, discipline and self-reliance, creativity and thoughtfulness. It is essential to develop in them the linguistic and mathematical skills, knowledge of science, information and communication technology, environment, health and population and life skills. it is also necessary to bring in them the feeling of preserving and promoting arts and aesthetics, humanistic norms, values and ideals. It has become the need of the present time to make them aware of respect for ethnicity, gender, disabilities, languages, religions, cultures, regional diversity, human rights and social values so as to make them capable of playing the role of responsible citizens with applied technical and vocational knowledge and skills. This Learning Resource Material for Animal Science has been developed in line with the Secondary Level Animal Science Curriculum with an aim to facilitate the students in their study and learning on the subject by incorporating the recommendations and feedback obtained from various schools, workshops and seminars, interaction programs attended by teachers, students and parents.

In bringing out the learning resource material in this form, the contribution of the Director General of CDC Dr. Lekhnath Poudel, Prof. Dr. D.K. Singh, Dr. Krishna Kafle, Shambhu Shah, Dr. Hari prasad panta, Dr. Amod Thapa magar, Dr. Raj Kumar Yadav, Dr. Binod Kumar Yadav, Dr. Suraj Gurung, Dr. Ganesh Gautam is highly acknowledged. The book is written by Dr. Shushila Shrestha and the subject matter of the book was edited by Badrinath Timsina and Khilanath Dhamala. CDC extends sincere thanks to all those who have contributed in developing this book in this form.

This book is a supplimentary learning resource material for students and teachrs. In addition they have to make use of other relevnt materials to ensure all the learning outcomes set in the curriculum. The teachers, students and all other stakeholders are expected to make constructive comments and suggestions to make it a more useful learning resource material.

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Ministry of Education, Science and Technology
Curriculum Development Centre

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Unit 1
Milk

Objectives

On completion of this chapter, the students will be able to know about:

- Definition of milk and colostrum
- Composition and nutritive value of milk
- Physical properties of milk
- Factors affecting the composition of milk
- Flavors and off-flavors

Content

1.1 Definition of Milk and Colostrum

Milk is whitish nutritious fluid produced and secreted by the mammary glands of mature female mammals and used for feeding theiry own until weaned. Colostrum is a yellow fluid secreted by the mammary glands of mammals for the first two or three days after the birth of a baby. It is thicker, more concentrated in protein and lower in fats than true breast milk. It is rich in antibodies that protect the newborn against diseases and proceeds the production of true milk, also called foremilk. It also has laxative effect.

1.2 Composition and Nutritive Value of Milk

Milk is mainly composed of water, proteins, fats, lactose, and ash. These are considered as major components of the milk whereas minor components include vitamins, enzymes,pigments and minerals.

Water

- Milk is the only source of water for neonates
- Water provides the suspension of organic component of milk (soluble protein i.e lactal albumin, lactalglobulin), lactose,Na, K, vitamin A,D,E.K
- Water provides medium for the milk removal

Lactose

- It is the major carbohydrate in milk
- This acts as the readily digestible source of energy for the neonates

Milk fat

- This is an energy source for neonate
- This is the most variable component of milk (between species and within species). E.g. seal: 53.2%, whale: 34.8%, donkey: 1.2% and horse : 1.6%

Protein

- Milk protein consists of casein (80%) and whey (20%)

Composition of milk in different species of animal

Species	H_2o %	Protein %	Fat %	Lactose %	Ash %
Cow	87.0	3.3	4.0	5.0	0.70
Buffalo	82.05	4.0	7.98	5.18	0.79
Sheep	81.23	5.6	7.80	4.4	0.85
Goat	85.71	4.29	4.78	4.46	0.76
Mare	90.18	2.14	1.59	6.73	0.42
Elephant	67.8	3.1	19.6	8.8	0.70
Bitch	75.4	11.2	9.6	3.1	0.70

Nutritive value of milk

Milk is an energetic food item. Each quantity of milk is subjected to certain amount of energy. Energy content of 100 gram of milk

- Fat: 4.2 gm/100gm milk × 9Kcal/gm= 37.8 Kcal
- Protein: 3.4 gm/ 100gm milk × 4 Kcal/gm= 13.6 Kcal
- Lactose: 4.6 gm/ 100gm milk × 4 Kcal/gm= 18.4 Kcal

Total = 70 Kcal/ 100 gm of milk

- **Protein:** helps build and repair body tissues, including muscles and bones and play role in the formation of antibodies
- **Calcium** : Helps build and maintain strong bones and teeth
- **Riboflavin** : Supports body growth, red blood cell production and metabolism

- **Phosphorus** : Strengthens bones
- **Vitamin D** : Helps promote the absorption of calcium
- **Vitamin B** : Helps convert food into energy
- **Potassium** : Regulates fluid balance and helps maintain normal blood pressure
- **Vitamin A** : Promotes good vision and healthy skin
- **Niacin** : Promotes proper circulation

1.3 Physical properties of milk

The physical properties of milk are:

a. Colour

The colour of the milk ranges from a bluish white to a golden yellow or yellowish white.

- White colour: The white colour of the milk is due to the reflection of light by the dispersed fat globules, calcium caseinate and calcium phosphate
- Yellow colour: The yellow colour of the milk is due to the carotene pigment that is found in the green plants. The carotene pigment is a fat soluble yellow pigment and it is considered as a precursor of Vitamin A
- Bluish yellow colour: It is due to riboflavin and lactoflavin
- Green colour: green colour of whey is due to fewer amounts of fat particles

Factors affecting the colour of milk:

1. Breed of animal: The Jersey breeds produce fat with deepest yellow colour while the Holsteins and Ayrshires produce fat with the lightest colour.
2. Feeds: Green forage and carrots are rich in carotene so, animals fed with these feed tend to produce milk with deeper yellow colour than that produced by hay, white corn and oats.
3. Species of animal: Buffaloes have bluish white milk while cows have golden yellow milk.
4. Flavor and taste

   Freshly drawn milk tastes slightly sweet and mild aromatic flavor. Sweet taste is due to lactose and salty taste is due to minerals (mastitic milk).It varies

according to animal's species, feed and fodder. Sour taste is due to lactic and butyric acid.

a. Specific gravity

Milk is heavier than water. The specific gravity of cow milk varies from 1.018 to 1.038. It varies with temperature.

b. Boiling point

Boiling point of milk is 100°C to 100.2°C in both cow and buffalo milk.

c. Freezing point

Freezing point of milk ranges from -0.535°C to -0.55°C.

d. Surface tension

The surface tension of milk at 20°C is 54.5 dynes per cm. It decreases as the temperature is raised or fat percent is increased.

e. Viscosity

The viscosity of milk varies from 1.5 to 2 centipoises. The viscosity of milk is always higher than viscosity of water due to the presence of dissolved solids in milk.

1.4 Factors Affecting the Composition of Milk

1. Species

Milk fat is the most variable component of milk. It ranges from a little over 1% to greater than 50%. Aquatic mammals typically have high milk fat percentage.

Lactose ranges from only a trace to less than 7%. Some species such as bear, kangaroo have very little lactose in milk.

Milk protein concentration ranges from 1% to about 14%. Generally milk protein percentage is positively correlated with milk fat percentage.

2. Breed

The composition of milk varies within a breed. Lactose content is fairly constant among breeds, milk fat varies extensively (Jersey and Guernsey are highest and Holstein is lowest), and protein varies somewhat among breeds.

3. Change occurring during a normal lactation

Composition of milk varies considerably during a lactation, with the major changes usually occurring soon after the start of lactation. The first secretion to be collected from the gland is called colostrum. The composition of the secretion gradually changes to that of mature milk.

4. Day to day variation

There is day to day variation of milk due to following factors:

- Excitement
- Estrous
- Incomplete milking

Milk fat is lowest in the fore milk and gradually increases in percentage as the milk is removed. The last milk out of the gland is highest in milk fat content.

5. Age of cow

As the age increases there is gradual decline in protein, fat and SNF level of the milk.

6. Pregnancy

In late lactation there is increase in SNF and protein level of the milk.

7. Temperature

This is inversely proportional with the protein and SNF level. With the increase in temperature beyond 21°C and below 1.1 °C there is increase in fat content of milk.

8. Exercise

Slight exercise will contribute in the increment of the fat level by 0.2 to 0.3% without change in quantity. Whereas moderate to heavy exercise will decrease in milk secretion and there will be substantial increment of the fat percentage. However there will be no effect of exercise over the SNF.

9. Disease

Mastitis will lead to decrease in fat, SNF, protein and lactose. However there

will be increment of the Cl, Na, Cu, Fe, Zn, Mg and a decrease in Ca, P, Mb, K. but ketosis will lead in elevation of fat level.

10. Feeds

Diet favoring acetic acid production during fermentation in rumen will contribute in milk fat percentage. So, for this diets should be provided in pelleted form. Also heat treated feed and finely grained hay will contribute in fat percentage of the milk.

11. Dry period and body condition

This period is essential to generate milk secretory tissue and to replenish body supplies.

12. Season

During winter there will be greater percentage of fat in comparison to the summer season

1.5 Flavors and Off-flavors

The flavor of milk should be pleasantly sweet and full, and have a clean, pleasing aftertaste.

Off-flavors commonly found in milk can be classified in three basic categories

1. Absorbed - feedy, barny, cowy, unclean, weedy, fishy, and musty.
2. Bacterial - acid, malty, unclean, fruity, bitter, sour, and putrid.
3. Chemical - cowy (ketosis), rancid, oxidized, sunlight, and medicinal.

Note: Absorbed flavor defects can develop before, during and after milking. It can occur when milk is left uncovered in the consumer's refrigerator or kept in cold rooms and dairy cases with other odor-producing foods.

Bacterial degradation results from bacteria that get into the milk upon contact with improperly washed or sanitized equipment, from external contamination, and is made worse by improper cooling.

Chemical defects can occur both before and after milking. The cowy or ketone flavor is the result of the animal suffering from ketosis. A foreign flavor can be caused by medications, a reaction to pesticides, disinfectants, or any number of

contaminants. Rancidity and oxidation result from the degradation of milkfat.

Learning Process and Support Material

a. Visual method

b. Observation method

c. Demonstration method

Allow the students to study about physical properties of milk and differentiate between normal milk and colostrum, off flavors of milk.

Materials required

- Milk of cow and buffalo
- Colostrum
- Off flavor milk
- Videos of milk

Assessment

1. Define milk (1)
2. Define Colostrum. (2)
3. Explain the factors that affect the composition of milk. (4)

Glossary

- Laxative : something that help emptying of bowels (faeces)
- Fermentation: process in which a substance breaks down into a simpler substance by microorganism like yeast and bacteria
- Ketosis: an abnormal increase of ketone bodies in the body
- Surface tension: phenomenon attributed to the attractive forces or cohesion between the molecules of the liquid exposed to surface areas
- Viscosity: resistance to flow caused by intra-molecular attraction

References

- A text book of animal husbandry by G.C. Banerjee

Unit 2
Lactation

Objectives

On completion of this chapter, the students will be able to know about:

- Anatomy and physiology of mammary gland
- Hormones affecting for gland development, lactation and involution
- Milk synthesis process

Contents

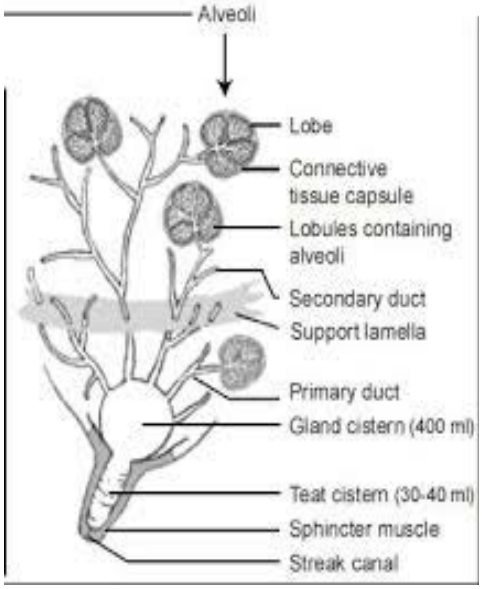
2.1 Anatomy and Physiology of Mammary Gland

The mammary gland of cattle, sheep, goat, horses and camel are located in the inguinal region; those of primates and elephants in the thoracic region; and those of pigs, rodents and carnivores along the ventral structure of both the thorax and the abdomen. Normally cattle have four functional teats whereas sheep and goat have two teats.

The mammary glands are modified sweat gland and located outside the abdominal cavity. The mammary glands or udder is covered with fine hair except teat which is totally hairless. The udder is composed of two halves, the right and left, divided by median suspensory ligament. Each quarter is composed of secretory tissues and supporting connective tissues. The secretory tissues consists of numerous alveoli lined with many secretory cells.Alveoli are known as the basic functional units of the lactating mammary gland. Each alveolus is supplied with tiny capillaries which lie outside the secretory cells. Small muscle fibres, called myoepithelial cells also surround each alveolus which cause contraction of the alveoli and produce “let down” of milk.

Each alveolus is drained by a small duct called “terminal duct”. A cluster of alveoli and their ducts look like a bunch of grapes known as lobule. A group of lobules are surrounded by a septum of connective tissue and form a lobe. The terminal duct unite to form intralobular duct. These ducts unite successively to form larger ducts called interlobular, intralobar and interlobar ducts. The interlobar ducts join to gland

cistern or milk cistern, a sinus at the tip of the udder. The gland cistern connect the teat cistern. The teat cistern is joined with the streak cannal, a narrow tube that open at the lower end of the teat. The streak canal is surrounded by a muscular sphincter which remains constricted and prevent leakage of milk except during suckling and milking. The streak canal and its sphincter are also responsible for preventing entrances of bacterial and other contaminants into the teat.



connection of duct with the Lobule-alveolar system

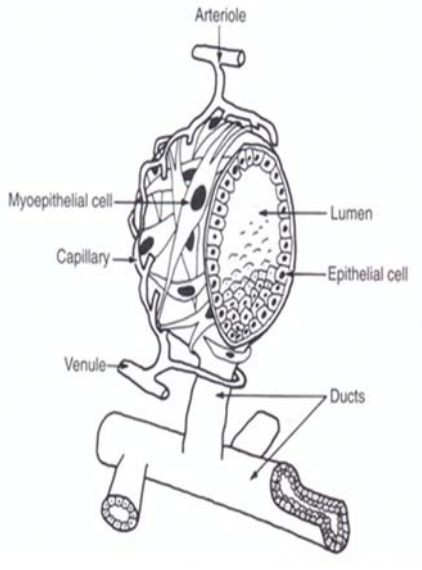


Fig: Alveolus

Milk collecting system

Milk is formed in the epithelial cells of the alveolus. The alveoli are surrounded by contractile myoepithelial cells that are involved in the milk-ejection. Milk from the alveoli is passed via many thousands of small ducts into eight to twelve main milk ducts. These lead into the gland cistern, and the milk leaves the teat via the streak canal and papillary duct. Each cell of the udder including of epithelial cells of alveoli are in intimate contract with blood, lymph, and nerve supply.

Blood which supplies milk constituents to the udder, comes from the heart. Then, after passing round the alveoli in the udder, the blood enters the venous system and returns to the heart.

2.2 Hormones Affecting for Gland Development, Lactation and Involution

Hormone is a chemical substance produced in the body that controls and regulates the activity of certain cells or organs.

Hormones affecting for gland development

Estrogen promote duct growth while proper combination of estrogen and progesterone stimulate lobule-alveolar development. At terminal stage of pregnancy, prolactin and growth hormone are also required for mammary gland development

Hormones affecting for lactation

Lactation mean secreting and giving of milk by the mammary glands.

Initiation of Lactation (Lactogenesis)

By the end of pregnancy, the cow's udder is fully developed for nursing. Immediately after parturition, removal of placenta decrease the secretion of hormone estrogen and progesterone. Hence inhibitory effects of these two hormones are reduced and allows marked production of prolactin. Prolactin is also known as lactogen, luteotropin, galactin and mammotropin.

Prolactin stimulate increased enzyme activity which in turn stimulate milk secretion. Along prolactin, growth hormone and the adrenocorticosteroid are required for sudden onset of milk secretion

Maintenance of lactation (Galactopoiesis)

Along with prolactin, STH (growth hormone), ACTH (Adrenocorticotropic hormone), TSH (Thyroid stimulating hormone) and oxytocin from pituitary gland are essential. Similarly, hormone like parathyroid, placental lactogen and insulin from non-pituitary are concerned with maintenance of lactation.

Hormones affecting for Involution

Involution is the process by which the mammary gland returns to its non-lactating state. Involution is characterized by a decrease in the number of mammary epithelial cells and also in the amount of secretory activity per cell. Lysosomal enzymes are released, and many epithelial cells are lysed. Myoepithelial cells remain in the gland during involution and maintain the structure of the remaining epithelial cells. The

space previously occupied by the degenerating alveoli is replaced with adipose cells. Estrogen may have an effect on the transition of mammary function from a lactating state to an involuting state.

2.3 Milk Synthesis Process

Milk synthesis takes place inside the epithelial cells lining of the alveoli. It contains a single layer of epithelial secretory cells surrounding a central storage area called the lumen, which is connected to a duct system. The secretory cells are, in turn, surrounded by a layer of myoepithelial cells and blood capillaries. Some milk components i.e vitamins, minerals and some proteins are not synthesized in the epithelial cells but rather are filtered from the blood through the epithelial cells and forms components of milk. Other components such as lactose, fat and most of the milk proteins are synthesized inside the epithelial cells from various blood precursors. All filtered components and the precursors pass into the alveolar cells through the plasma membrane which exert considerably selectivity concerning which blood substances are to be allowed to pass inside the cells.

Milking and sucking calf causes the release of a hormone called **oxytocin which begin the process ofmilk let-down**. As a result of this hormone stimulation, the muscles begin to compress the alveoli, causing a pressure in the udder known as letdown reflex, and the milk components stored in the lumen are released into the duct system. The milk is forced down into the teat cistern from which it is milked.

It is assumed that 400-500 ml of blood must pass through these cells for producing one ml of milk.

Learning Process and Support Material

Visual method

Teach student about the anatomy, physiology of mammary gland and milk synthesis process by showing different pictures and videos.

Support Material

- Posters showing anatomy of mammary gland
- Picture showing milk synthesis process
- Videos

Assignment

1. Define involution. (1)
2. List down the hormones affecting lactation. (2)
3. Describe the anatomy of mammary gland. (4)

Glossary

- Precursor: A substance from which another is formed
- Parturition: The process of giving birth to young
- Sphincter: A ring of muscle surrounding and serving to guard or close an opening
- Reflex: An action that is performed without conscious thought as a response to a stimulus
- Lumen: The cavity of a tubular organ
- Estrogen: Hormones which promote the development and maintenance of female characteristics of the body
- Progesterone: A hormone released by the corpus luteum that stimulates the uterus to prepare for pregnancy.
- Prolactin: A hormone that stimulates milk production after childbirth.
- Oxytocin: A hormone that causes increased contraction of the uterus during labour and stimulates the ejection of milk into the ducts of the mammary gland

Reference

A Text Book of Animal Husbandary by G. C. Banerjee

Unit 3
Dairy

Objectives

On completion of this chapter, the students will be able to know about:

- Introduction of dairy branches and scope
- History and importance of dairy sector
- Status of production, collection, processing and marketing of milk and milk products in Nepal
- Importance of milk and milk products

Contents

1.1 Introduction of the Dairy Branches and Scope

Dairy is a branch of agriculture that consists of breeding, raising of dairy animals primarily cattle and buffalo for the production of milk and the various dairy products processed from it. The branches of dairy industry are: fluid milk industry, cheese factory,frozen dairy desert factory, butter and ghee factory, dry milk product factory etc.

Scope of Dairy

- The barren land of the mountain and hill areas which are accessible for transport and unfit for cultivation can be used for dairy enterprises.
- Better nutrition and health care management and the adoption of disease/ stress resistance and high milk producing breeds can increase productivity of cattle and buffalo.
- Dairying is an important source of subsidiary income to small/ marginal farmers and agricultural labourers
- The manure from animals provide a good source of organic matter for improving soil fertility and crop yields
- The surplus fodder and agricultural by-products can be utilized for feeding the animals.
- Dairy farming is taken up as a main occupation where demand for milk is high.

- Livestock are widely distributed with even distribution of cattle and buffalo throughout the country.
- Market opportunities and demand of milk and milk products have increased particularly in the densely populated urban areas.

1.2 History and Importance of Dairy Sector

1.3 History of dairy sector

1952	Experimental production of Cheese
1953	Establishmnet of Yak Cheese Factory in Langtang under FAO
1954	Dairy Development Section was established under the Department of Agriculture and also a small scale milk processing plant was started in Tusal, Kavrepalanchowk
1956	Dairy Development Commission formed
1956	A central dairy plant with an average milk processing capacity of 500 liters per hour was established in Lainchour and mini milk processing plant was established at Kharipati in Bhaktapur district
1960	Two additional cheese factories were established
1960	Cheese Production and Supply Scheme (CPSS) was launched
1962	Dairy Development Commission was converted to the Dairy Development Board
1969	Dairy Development Commission was converted to the Dairy Development Coorporation under the Corporation Act of 1964
1970	Involvement of Private sector in Dairy processing
1973	Biratnagar Milk Supply Scheme was established by DDC
1974	Hetauda Supply Scheme was established by DDC
1978	Kathmandu Milk Supply Scheme established by DDC
1979	Milk Products Production and Supply Scheme (MPPSS) was established (Renamed CPSS)
1980	Pokhara Milk supply Scheme established by DDC
1990	"Ten Year Dairy Development Plan" was designed and approved. During this time the private dairies emerged significantly.
1991	First SMP plant in Biratnagar established

1992	Establishment of National Dairy Development Board (NDDB)
1998	An association of private sector dairies i.e Nepal Dairy Association (NDA) was formed by merging the different private sector associations. Nepal Cheese Producers Coorperative was formed
2000	Code of Conduct of dairy industries has been prepared to enhance quality production
2004	Privatization of Pokhara Dairy
2005	Code of conduct for Dairy industries has been prepared
2006	Community Livestock Development Programme started
2008	Dairy Development Policy

Importance of Dairy Sector

- Help in employment generation
- Help in poverty reduction.
- To contribute to national economic development
- Help to overcome from nutritional deficiencies.

1.4 Status of Production, Collection, Processing and Marketing of Milk And Milk Products in Nepal

In earlier days when there were no organized dairies, demand for milk was fulfilled by the direct supply from the milk producers. These producers used to go house by house and deliver the required quantity of milk to the households. Dahi (yoghurt) filled in clay containers were produced by some traditional dahi makers and milk-based sweets were prepared by traditional sweet makers. But now, the scenario began to gradually change with the increasing supply of pasteurized milk and modern dairy products such as cheese, butter, ice cream etc by different dairies. Many new sweet shops also started to emerge. Besides, different dairy products are also imported to fulfill the consumers' demand.

Processed liquid milk is the prominent product of the dairy industry as almost 80 percent of milk collection in the formal sectoris used to produce processed milk. Various brands of the locally produced as well as imported milk products of varying categories are sold inthe urban market. Milk products from more than 20 countries

from Asia, Europe, Australia and North America compete in the Nepalese market. Milk products being available inthe local urban markets indicate that there is ample demand for the modern as well as traditionaldairy products. The demand for dairy products in the urban markets is expected togrow in the future mainly due to the increasing population and rise inincome. Additionally, exposures to outer world mainly through the TV have particularly attracted the educated younger generation to consume the modern dairy products. Moreover, their demand is also expected to rise due to the increasing establishment of hotels and restaurants.

1.5 Importance of Milk and Milk Products

Milk and milk products are an important source of calcium which help to give us strong bones and teeth. They also provide protein (for growth and repair), carbohydrates and fat (for energy) as well as many important vitamins (vitamin A and Vitamin B12) and minerals (zinc).

- Consumption of curd has been found useful in the treatment of dyspepsia, dysentery and other intestinal disorders.
- Cheese is rich in protein, energy, calcium, phosphorus and fat soluble vitamin and easily digestible.
- Milk powder can be used as a substitute for mother's milk in baby food and used for preparing chocolate, ice cream and making bakery items.
- Paneer used to prepare different dishes
- Milk powder can be used in animal feed.
- Ghee is used in the manufacture of ice cream, bakery products, confectioneries

Learning Process and Support Material

Visual Method

Teach students by showing different videos and posters

Support Material

- Different videos / charts
- Posters

Assessment

1. Write down important of dairy sector. (1)

2. Write down the importance of milk and milk products. (2)
3. Highlight the history of dairy industries in Nepal. (4)

Glossary

Substitute: replace

Confectioneries: sweets and chocolates considered collectively.

Dyspepsia: indigestion.

Subsidiary: less important than but related

References

- Dairy Sector Study of Nepal by Faohttp://www.fao.org/3/a-y3548e.pdf

Unit 4
Clean Milk Production

Objectives

On completion of this chapter, the students will be able to know about:

- Methods of milking: hand and machine milking
- Clean milk production: concept and methods

4.1 Methods of Milking

Milking is the act of removing milk from the mammary glands of cattle, buffalo, goats, and sheep. Milking may be done by hand or by machine.

1. Hand milking

Hand milking is performed by massaging and pulling down on the teats of the udder, squirting the milk into a bucket. Two main methods of hand milking are:

a. Stripping Technique

In this technique teat is grabed in each hand by holding it between thumb and forefinger and drawing it down the length of the teat and at the same time pressing it to cause the milk to flow down in a stream.

b. Full Hand Technique

It is done by grasping the teat with all the five fingers and pressing it against the palm. The teat is compressed and relaxed alternately in quick successions, thus the method removes milk much quicker than stripping as there is no loss of time in changing the position of the hand. It is known to be superior than stripping method as it stimulates the natural suckling process by calf.

2. Machine milking

Milking machine are capable of milking number of cows quickly and efficiently, without injuring the udder, if they are properly installed, maintained in excellent operating conditions, and used properly. It performs in two basic functions:

- It opens the streak canal through the use of a partial vacuum, allowing the milk to flow out of the cistern through a line to a receiving container.

- It massages the teat, which prevents congestion of blood and lymph in the teat.

4.2. Clean Milk Production: concept and methods

Milk is biological in origin. Milk containing dirt, dust, foreign materials high bacterial count and with off, flavor is called a contaminated milk. Milk is contaminated by various sources like Udder, Exterior of cow's body, milking barn, flies, milker, utensils etc. On consumption of contaminated milk, one may get a' number of health problems.

As soon as it is drawn from the udder it is attacked by number of microbes. For retaining the original quality of milk, milk should be protected from microbial fermentation as soon as it is milked. Various post secretary factors are involved for changes in milk. To maintain hygienic quality risk of milk being attacked by micro-organisms should be minimized. For this during milking we should ensure cleanliness. Not only that but also one should avoid contamination of milk during subsequent handling. For clean milk production we should be careful enough not to draw milk in dusty environment. Milch animal's udder should be free from dirt and dust. Otherwise during the operation of milking it might fall in to the milk. To avoid milk residues left over as a source of microbial contamination it is essential that the vessel used for milking and for storage should be cleaned and rinsed using detergents after each milking.

Methods that should be followed for clean milk production

Clean milk production is of utmost importance to retain its nutritive value and keeping quality. Following methods should be followed for clean milk production:

a. Clean and healthy animals

Bacteria present on the animal body may enter in to the milk at the time of milking. Maintenance of, clean skin, washing flank and udder with clean damp cloth before milk reduces the contamination from this source. For this we can use clean brush and detergents or soap solution or potassium per manganite solution. We should also avoid initial stripping of milk. Milk will also develop odour from surroundings and utensils.

b. Milking barns

Milking barn should be dry, free from dirt,neat flooring and well ventilated

to avoid contamination from this source. Washing of milk parlour should be done regularly. Dry feeds or forage should be fed after milking.

c. Healthy milkmen

Milker is directly responsible in producing good quality milk. Dirty hands and clothing of the milker may be the source of contamination. Several bacterial diseases like T.B, Typhoid fever, diphtheria may be transmit from the milker, or handler to the consumer through milk. Proper dress of milkmen and personnel hygiene should be maintained. Also one should wash their hand properly before milking and avoid wet hand milking to avoid contamination. Similarly, Dirty habits like smoking, drinking should be avoided.

d. Control of insects and fly

They are source of contamination so, should be killed regularly. Insecticides should be sprayed in milk shed.

e. Utensils

Utensils are the containers or equipment in which the milk is handled, processed, stored or transported. Clean sanitized, smooth, copper free and dry utensils may be used for handling milk. First rinse the milk utensils with cold water followed by hand or brush scrubbing with cold water with the aid of washing soda or any detergents.

f. Boiling

Boiling help to keep milk for longer time. But during reduction of temperature at around 61 degree Celsius thermophilic bacteria may grow.

g. Chilling

Cooling below 10 degree Celsius will substantially decrease the microbial load.

Chilling equipments also should be clean to ensure clean milk after transportation

Learning Process and Support Material

a. Demonstration method

b. Visual method

c. Observation method

Teach students about the process of milking and clean milk production by showing on farm or different videos and allow them to do by themselves.

Support Materials

- Cow/ farms of farmer
- Video clips of milking

Assessment

1. Define contaminated milk.
2. Write down the methods of milking.
3. Write down the methods that should be followed for clean milk production.

Glossary

- Insecticides: substance used to kill insects
- Thermophilic bacteria: bacteria that require optimum temperature of 55-75^{o} for their growth
- Humidity:amount of water vapour present in the atmosphere
- Milking barn: building used for milking and storage of milk

References

A text book of animal husbandry by G.C. Banerjee

Unit 5
Micro-organisms Common to Raw Milk, Pasteurized Milk and Milk Product

Objectives

On completion of this chapter, the students will be able to know about:

- Microorganisms common to raw milk, pasteurized milk and milk products

Contents

Milk and milk products are very good media for the growth and development of a number of micro-organisms. Some organisms are desirable and some are harmful and pathogenic. When these organisms come in the milk it causes change in taste, odor or appearance of milk. The importance of knowledge of the microorganism of dairy products are:

- Pathogenic bacteria in milk and milk products may spread diseases
- Milk and milk products may be spoiled by the action of micro organisms
- Certain dairy products can be made only by controlled action of specific micro-organisms

The various microorganisms found in milk and milk products are of following types:

a. Acid producers/lactose fermenters

Those bacteria, which are responsible for conversion of lactose to lactic acid, are included in this group

1. Streptococci: These are non-pathogenic and important to dairy industry

Strept ococcus cremoris (S. cremoris): important member of starter cultures. It produces good flavor of ripened cream

Strept ococcus lactic: They are responsible for normal souring of milk. It is desirable in milk and milk products.

Strept ococcus thermophiles: important for preparation of yoghurt

S. citrovorus, S. paracitrovorus, and S. diacetilactis: responsible for

production of desirable aroma and flavor in milk products, especially in butter.

2. **Lactobacilli:** They play an important role in ripening of cheese and in preparation of certain types of sour milk. E.g. *Lactobacillus bulgaricus*, *L. acidophilus, L. casei*

b. Peptonizing organisms

These organisms decomposes the protein (casein) and responsible for sweet curdling and development of abnormal colors of milk. These are undesirable organisms in milk. These organisms found in milk and milk product can be classified into:

i. Sweet curdling organisms

- Aerobic spore forming: These organisms are common contaminants in milk. E.g. *Bacillus subtilis, B. mesentricus, B. cereus, B. mycoides, B. novus*
- Aerobic non spore forming rods: *Proteus vulgaris, Pseudomonas fluorescens*

ii. Organisms responsible for the development of abnormal colors in milk

- Blue colour: Bacillus cyanogens
- Yellow colour: B. synnanthus
- Red: B. prodigiosus

c. Fat splitting organisms/ lipolytic organisms

These organisms are responsible for tallow flavor, rancidity and bitter tastes in milk and cream. Bacteria which causes lipolysis are Pseudomonas fluorescens, P. fragi, Achromobacter lipolyticum and moulds such as: Oidium lactis and Penicillium.

d. Aroma producing bacteria: These bacteria are responsible for the production of desirable aroma and flavor in milk product. *E.g.Streptococcus citrovorus, Streptococcus paracitrovorus, Streptococcus diacetilactic*

e. Gas producing bacteria

These are undesirable type of bacteria that ferment lactose and produce acid and gas i.e. lactic acid and co2. E.g. E. coli, Aerobacter acrogens

f. **Toxin producing bacteria:** *Salmonella, Strepylococcus* produce poisonous substances which are toxic to man and animals.

g. **Yeast** : The yeast most frequently encountered in milk and milk products act upon the lactose to produce acid and carbon dioxide. Torula lactis, Torulus mycoderma, Saccharomyces are the yeast that can produce acidity which inhibits the activity of organisms and also imparts flavor and aroma in dairy products.

h. **Mould :** Moulds are multi cellular organism, which are not visible by our naked eye, at maturity they may observe as mycelium. Generally aerobic moulds are significant to dairy products. It is used in mould ripened cheese varieties. It causes discoloring of milk along with producing smell and odors. Common genera are *Penicellium, oospora, Aspergillus, mucor, Monilia etc.*

Some moulds are of significant importance in different types of cheese production while others spoil the dairy products under their favorable conditions.

i. **Viruses :** The virus are usually not destroyed by normal pasteurization of milk employed for cheese and cultured buttermilk, but they can be destroyed by higher heat treatment.

j. **Pathogenic organisms** : These can be grouped in two classes:

- Organisms originating from the cow

  Mycobacterium tuberculosis, Brucella abortus, Streptococcus agalactiae, Staphylococcus aureus, Salmonella spp., Coxiella burneti, Corynebacterium pyogenes

- Organisms originating from persons handling the milk

  Salmonella typhi, S. paratyphi, Shigella dysenteriae, Hemolytic streptococci, Escherichia coli, Clostridium perfringes, Corynebacterium diphtheria

Learning Process and Support Material

- Visual method

- Observation method

Teach the students by showing Milk and milk product prepared by using different micro-organism and milk and milk product spoiled by microorganism and its color, odor and taste.

Support Material

Different charts and videos of micro-organism

Assessment

1. Write down the name of two diseases that can be transmitted to the human.
2. Write down the importance of knowledge of the microorganism of dairy products.
3. List down the microorganisms found in milk and milk products.

Glossary

- Pathogenic bacteria: bacteria which causes diseases to human and livestock
- Putrefying bacteria: bacteria decomposing organic matter
- Mesophilic bacteria: bacteria which require optimum temperature of 30-37^{o}C for their growth
- Curdling : to change into the curd
- Rancidity: the spoilage of a food in such a way that it becomes undesirable (and usually unsafe) for consumption

Reference

Types of microorganisms and their activity in milk
https://www.uoguelph.ca/foodscience/book-page/types-microorganisms-and-their-activity-milk

Unit 6
Milk Quality and Its Test

Objectives

On completion of this chapter, the students will be able to know about:

- Concept of milk quality
- Characteristics of quality milk
- Factors affecting milk quality
- Quality assurances in milk collection
- Organoleptic test
- Alcohol test
- COB test
- Fat test
- SNF test
- Tests of processed milk

Contents

6.1 Concept of Quality Milk

Good-quality milk has to be free of debris and sediment, free of off-flavours and abnormal colour and odour, low in bacterial count, free of chemicals, and of normal composition and acidity. Good raw milk quality is the basis for the production of high quality dairy products. To achieve this quality, good hygiene practices should be applied throughout the dairy chain.

6.2 Characteristics of Quality Milk

The quality milk should have following characteristics

- Quality milk should be of normal colour
- Good quality milk should be free of off-flavour
- Quality milk should not contain any adulteration like water, preservatives, added solid etc.
- Quality milk should be free of chemicals (e.g. antibiotic residues, detergents)

- Somatic cell count should be less than 100,000 cells/ml in quality milk
- Quality milk has to be free of debris and sediment
- Quality milk should be of normal composition and acidity
- Quality milk should be low in bacterial count

6.3 Factors affecting milk quality

a. Microbiological quality

- Endogenous source (cow itself)
- Exogenous source
    - Environment (soil, water, manure, human contact etc)
    - Collection and processing equipments
    - Human milk handlers on the farm and in the factory

b. Milk Composition

- Species
- Genetic differences within species
- Breed differences: milk from Holstein cows has a lower milk fat % than milk from Jersey
- Stage of lactation: fat %, vitamin A & D, Ca, Mg, P, Cl is higher in colostrum than in milk.
- Change in milk composition during milking: first drawn milk contain 1-2 % fat whereas at the end of milking fat % may be 5-10%
- Seasonal variation: milk fat and SNF are higher in winter and lowest in summer.
- Diseases : infection of udder (mastitis)greatly influences milk composition

c. Milk somatic cell count

High somatic cell counts (SCC) present in milk are the main indicators of mammary gland infection. Normally, in milk from a healthy mammary gland, the SCC is lower than 100,000 cells/ml. An elevated SCC in milk has a negative influence on the quality of raw milk

d. Antibiotic residues

6.4 Quality Assurance in Milk Collection

The quality of the milk is dependent partly upon its condition on arrival at the receiving platform and partly upon the efficiency of the processing methods. Upon receipt of the milk at the collection center several inspections and test should be carried out at milk collection center before processing for assurance of milk quality. Milk can be tested for:

- quantity – measured in volume or weight;
- organoleptic characteristics – appearance, taste and smell;
- compositional characteristics – especially fat, solid and protein contents;
- physical and chemical characteristics
- hygienic characteristics – hygienic conditions, cleanliness and quality;
- adulteration – with water, preservatives, added solids, etc.
- drug residues.

Note: Examples of simple milk testing methods suitable for small-scale dairy producers and processors include taste, smell, and visual observation (organoleptic tests); density meter or lactometer tests to measure the specific density of milk; clot-on-boiling testing to determine whether the milk is sour or abnormal; acidity testing to measure the lactic acid in milk; and the Gerber test to measure the amount of fat in the milk.

6.5 Organoleptic Evaluation

The test perform by utilizing the sense of sight, smell and taste is known as organoleptic examination.

The sample of milk is examine and record the observation on following aspect.

1. Odor/smell
    - It can be judged within few seconds
    - Remove the lid and inhale the smell
    - Record the odor/ smell as normal or abnormal
    - Milk should be free from any off flavor like feed, fishy, barny etc.
2. General Appearance

- It should be observe whether the milk is clear or contain any visible dirt or foreign matter.

3. Colour:

   Observe the colour of milk and record it whether colour of milk is normal or abnormal. Normal colour of milk are white, yellowish, light yellow. Abnormal colors are reddish, bloody, bluish etc.

4. Consistency

   Record the consistency of milk as normal, watery, thick, ropy and slimy.

5. Temperature

   Note the temperature of milk at the time of receiving. It should be below 5°C.

6.6 Alcohol Test

The test is done to detect abnormal milk such as colostrum or mastitis milk. The procedure are as follows:

- Take 5ml of milk in test tube
- Add equal quantity of 68% Ethyl alcohol
- Mix the contents of the test tube by inverting several times
- Examine the tube and note any coagulation. Presence of flake or curd denotes positive alcohol test. Such milk are rejected.

6.7 Clot on Boiling (COB) Test

If milk is kept as such at room temperature, there will be increased in the acidity. If acidity is increased to more than 0.2 percent, there is coagulation due to heat treatment. Hence it is essential to know the heat stability of incoming raw milk for further processing.

- Take 5 ml of milk in the test tube
- Put this on boiling water bath or in flame for 5 minute
- Remove the tube from water bath without shaking
- Note any acid smell or clotting particles on the sides of the test tube
- Sample showing clotting particles are recorded as positive COB Test. Such milk

is rejected on the platform

6.8 Fat Test (Gerber Method)

Fat is the most important constituent of milk as it is used as a basis for fixing the purchase and sale price of milk. It helps to detect adulteration like watering and skimming of milk. The fat level in milk is determined by Gerber method.

The procedure for fat test are as follows:

10.94 ml. of milk at 20 degrees Celsius is added to a butyrometer together with 10ml sulphuric acid and 1ml amyl alcohol. After centrifugation, the sample is put in a 65 degrees Celsius water bath and read after 3 minutes. The fat content from this reading should not be less than 3%.

6.9 SNF (Solid Not Fat) Test by Using Lactometer

The test is done to estimate the level of total solid content of milk. The quality of milk is determined on the basis of total and SNF

SNF is estimated by using lactometer. The specific gravity of milk is measured usually with lactometer. It works on the principles that the body floating in liquid sinks to such a level that it displaces a volume of liquid equal in weight of the floating body.

6.10 Tests of Processed Milk

1. Tests for efficiency of pasteurization:

a. Phosphate test

This test is done for testing the efficiency of pasteurization. The test involves the detection of phosphate enzyme in pasteurized milk. When milk is pasteurized the phosphateenzyme is destroyed. The presence of phosphate enzyme in pasteurized milk either indicates (a) inadequate heat treatment or (b) addition of raw milk to pasteurized milk

b. Sensory evaluation

This is the judging of the quality of milk by its taste and smell. Milk is smelled and observed visually to see if there are any defects on appearance such as filling of the milk, colour, visibility purity, presence of foreign matters, spots

of mould etc.

c. Test for developed rancidity

a. The pH value for fresh milk is normally 6.5-6.7. If there are high number of micro-organisms acidity is increased in pasteurized milk.

2. Microbial Analysis

b. standard Plate Count (SPC)

The standard for total plate count for pasteurized milk is 20,000/ml and pasteurized cream is 100,000/ml.

b. Coliform Count

All coliform bacteria in milk are killed by pasteurization. Presence of coliforms indicate contamination after pasteurization or unsanitary condition during production, processing or storage.

Standard values for pasteurized milk for coliform count

a. Less than 1 colonies/ ml----------satisfactory

b. 1-10/ ml----------not quite satisfactory

c. More than 30/ml----------unsatisfactory

1. Compositional test

a. Determination of Fat

It is done to examine the quality of pasteurized milk whether the producer has maintained the standard percentage of fat.

b. Determination of SNF percentage of milk

It is done to examine whether manufacturers has maintained the standard for SNF in pasteurized milk by using lactometer.

Learning Process and Support Material

a. Visual method

b. Demonstration method

c. Observation method

Materials Required

- Milk
- Chemicals for different test
- Video of quality milk production process

Allow students to perform organoleptic test and other tests in laboratory

Assessment

1. Define quality milk.
2. What do you mean by organoleptic test?
3. Write down the factors affecting milk quality.
4. Write down the test performed for processed milk.

Glossary

- Coagulation: to change from a fluid into a thickened mass
- Porcelain crucible: a vessel or container made of materials that resist great heat
- Desiccator: a glass container or other apparatus holding a drying agent for removing moisture from specimens and protecting them from water vapour
- Residue: a small amount of something that remains after the main part has gone or been taken or used

References

Factors affecting quality and quantity of milk in dairy cattle by Dr. Irshad A. (2015)

Milk testing and quality control by FAO http://www.fao.org/ag/againfo/resources/documents/MPGuide/mpguide2.htm

Unit 7
Buying and Collection of Milk

Objectives

On completion of this chapter, the students will be able to know about:

- Buying and collection from vendors and producers
- Selection of producers from milk collection
- Payment systems based on weight, volume, fat and SNF

Contents

7.1 Buying and collection from vendors and producers

Milk collection is one of the first activities for the processing of milk. Once the milk is collected from vendors and producers in a central location, the milk can be transported to processing centers. Milk should be collected within four hours of milking.

7.2 Selection of Producers for Milk Collection

Following points should be considered for selection of producers:

- number of milk producers
- milk volume of each producer
- total volume of milk
- time to transport the milk
- distance from members to the collection center
- distance from the collection center to the processing center or market
- whether milk collection is once or twice per day.

7.3 Payment systems based on weight, volume, Fat and SNF

When milk arrives at the collection center, information on the milk is needed. This information could be quantity, quality, hygiene, composition, whether water has been added, etc. This is needed to determine the amount of money that milk producers will get. Milk can be priced according to:

- quantity

- composition
- hygiene
- combination of these criteria

Based on weight or volume

This is the simplest method and it is easy to calculate. Weighing machine or a spring balance can be used to measure weight or volume of milk. A spring balance can give inaccurate readings and might have to adjust the balance frequently so, precaution should be taken. This has the disadvantage that milk may not be of a better quality.

Based on Fat amount

This payment method is based on the amount of fat present in milk. If we use fat percentages instead of fat (in kg), a farmer would get more money if he or she adds water to the milk. To prevent farmers from adding water, it is better to use a payment system based on kilograms of fat.

Based on SNF

In this system, payment is based on SNF present in milk. The yield of milk products will depend on the amount of total solids (TS) present. The greater the amount of fat and protein in milk the greater the yield of cheese, and milk with a high fat content gives more butter than milk with a low fat content.

Learning Process and Support Material:

a. Visual method

b. Demonstration method

Visit the students to different collection center and shows different videos

Support Material

- Collection center
- Videos of milk collection center

Assessment

1. Define SNF.
2. List out the points that can be considered during Selection of producers for

milk collection.

3. Write about the paying system of milk.

Glossary

Vendor:someone who is selling something

Solid Not Fat (SNF): the constituents of milk other than fat and water

Reference

Milk producer group resource book by FAO*http://www.fao.org/3/a-y3548e.pdf*

Unit 8
Rreception and Pretreatment of Milk

Objectives

On completion of this chapter, the students will be able to know about:

- Reception and storage of milk
- Platform sampling and testing
- Pretreatment process

Contents

8.1 Reception and Storage

Milk reception refers to the accepted transfer of raw milk from the farm by dairy. Raw fresh milk is received at the processing plant in cans or tanks directly from a producer or from a collection center. The milk-receiving platform at dairy plant should be elevated to facilitate convenient handling of cans. Reception area should have weighing machine, a can steaming block, can washer, temporary storage after weighing, and a high capacity milk pump for pumping milk from this tank to a chiller. This cools the milk on line before it reaches into a storage tank. The reception section should have a small laboratory to conduct platform test and recording of the milk being received.

The raw milk are store in storage tank which are usually made of double walled horizontal stainless steel. These are insulated tanks which prevent increase in the temperature of chilled milk

8.1.1 Intake of Milk in Cans or from Tanker

Milk is received in the processing plant from the primary producers or the milk collection centers. Usually they are transported by cans or bulk containers (milk transport tanks or vans).

8.1.2 Storage of Milk

Usually milk is held up to a maximum of 72 hours between receptions and processing in the tank. The tanks may be cylindrical or oval. The storage tanks are often kept outdoors with heads extended through the wall into processing room.

Milk temperature is maintained at less than 7°C and tanks must be designed for sanitizing, preferably for CIP. Surfaces must be smooth and easy to clean. All closed type tanks must be equipped with a manhole, either round or oval in shape to permit access to the interior for cleaning and inspection.

8.2 Platform sampling and testing

It is a rapid test done for acceptance or rejection of incoming milk. It include the test for judging the quality of the raw milk. These are:

a. Organoleptic evaluation
b. Clot on boiling test (COP)
c. Alcohol test (AT)
d. Sediment Test (ST)
e. Resazurin test (RT)

8.3 Pretreatment

8.3.1 Clarification

Clarification mean Separation of non-dairy solids and milk fat content, in order to obtain a clean product with the desired fat content according to the final destination.

8.3.2 Cream Separation

Cream separation is a process by which the milk is separated into cream and skim milk by centrifugal and gravitational force. The milk enters the rapidly revolving bowl of the separator. The inflow of milk is channelized to the outer wall of the bowl and fills it from outside towards the center. The centrifugal and gravitational forces keep on continuously and help to separate the skim milk and cream. Skim milk is thrown towards the outer periphery and channelized to skim milk out let, while the cream is channelized to the central core and forced out through cream out let.

8.3.3 Homogenization

Homogenization is the process of breaking down the larger fat globules (4-5 microns) in the milk into smaller globules of approximately less than 2 microns to make uniform suspension of the fat. Hence there will be increase in viscosity

because milk protein are absorbed on the surfaces or these fat globules. It is done by forcing the liquid through a very small orifice under suitable temperature and pressure.

8.3.4 Standardization of Milk

Standardization of milk refers to the adjustment, i.e. raising or lowering, of the fat and/or solids-not-fat percentages of milk to a desired value, so as to conform to the legal or other requirements prescribed. It is commonly done in cases of market milk supply and also in case of manufacture of milk products e.g. condensed milk, milk powder, ice cream and cheese etc. The standardization is mostly done to have uniform milk fat content in the finished dairy product. Milk is standardized by the addition of milk or cream with a higher or lower fat percentage than that of the material to be standardized; sometimes the addition of skim milk will fulfill the purpose.

There are two calculation methods by which we can solve the standardization problems.

a. Pearson's Square Method

b. Algebraic Method

Learning Process and Support Material

a. Visual method

b. Demonstration method

Visit the students to different milk collection center and dairy industries

Support Material

- Videos
- Dairy industries

Assessment

1. Define clarification.
2. Define platform test and enlist them.
3. Write down about pretreatment of milk?

Glossary

- CIP: Clean In Place
- Microns: a unit of length equal to one millionth of a metre

References

Meena, S. (2017). Different platform tests for raw milk at raw milk reception dock. pp.1. Chapter 4.

Unit 9

Heat Treatment of Milk and Processing of Liquid Milk

Objectives:

On completion of this chapter, the students will be able to know about:

- Objectives of heat treatment
- Introduction of pasteurization
- Packaging, storage and distribution of processed milk

Contents

9.1 Objectives of heat treatment

- To safeguard public health by destroying all pathogenic bacteria
- To extend the keeping quality of liquid milk by destroying most of the milk-souring micro-organism
- To ensure a product with a good keeping quality

9.2 Introduction of Pasteurization

The process of pasteurization was named after Louis Pasteur, a French chemist/microbiologist, who discovered that spoilage organisms could be inactivated in wine by applying heat at temperatures below its boiling point.

Pasteurization is one of the important processes in the treatment of milk. It is process of heating every particle of milk or milk products to at least 62ºC for 30 minutes or at least 72ºC for 15 seconds in approved and properly operated equipments. Bacteria of TB, typhoid fever, scarlet fever, diphtheria, brucellosis can be killed by the process of pasteurization.

Methods of Pasteurization

1. Low temperature long time (LTLT)
    - In this process, the milk is heated at 62ºC for 30 minutes
    - This method is suited for small scale operation upto 900 lts
    - This has an low initial cost
    - This can also be hand operated

2. High Temperature Short Time (HTST)

- In this process, milk is heated at 71ºC to 72ºC for 15 seconds
- It is also known as continuous flow or flash pasteurizer
- The entire process is continuous and automated
- This method is applicable to liquid milk, cream, and other liquid milk products

9.3 Packaging, Storage and Distribution of Processed Milk

Packaging is defined as placing a dairy commodity into a protective wrapper or container for transport or storage. The package must perform following functions

- To contain the product: the package should be adequately holding the product in size, volume, strength to withstand handling and storage
- To protect the product: the package should safeguard the product against contamination, evaporation, air, accidental spillage etc.
- To help in transportation of the product: the package should easy to handle, transport, load, unload and carrying one place to other.
- To help in marketing the product: the package should be suitable, comfortable, appropriate, informative and favorable to dispensation and reclosure and to its disposal or reuse.

Feature of packaging

- Protect, preserve and contain the product
- Economical packaging
- Printable on the external surface (quantity, brand, quality, instruction for consumer etc)
- Non-reactive to product
- Nontoxic to human
- Attractive to consumer
- Easy to open, store and dispose
- Easy to handle and transport the product
- Easy to operate at low cost

- Suitable to pack the product

Storage

Pasteurized milk has a shelf-life of 2-3 days if kept at 4°C in a clean crates. Milk packets should be checked for leaking. If packaged in sealed bottles and stored at room temperature, sterilized milk should have a shelf-life in excess of six months.

Distribution

Delivery van used for distribution of processed milk and milk products should be clean and closed. Milk and milk products should be sold in clean shops with shades to avoid direct sunlight and cold chain system should be maintained to keep the temperature of milk below 10ºC.The processed milk are distributed to the wholesalers. Wholesalers distributed to retailers or either delivery to the consumers. The retailers distributed to the consumers. Some of the remaining unsold milk are again returned to the plant.

Learning Process and Support Material

a. Visual method

b. Demonstration method

Visit the students to the dairy industry and shows different videos of heat treatment of milk and processing of liquid milk

Support Material

- Video of processing of liquid milk
- Dairy industries

Assessment

1. Define packaging.
2. List out the features of packaging.
3. Explain pasteurization and its types.

Glossary

- Retailer: a person or business that sells goods to the public in relatively small quantities for use or consumption rather than for resale.
- substantial

References

Dairy Sector study of Nepal by FAO

http://nepalagritech.com.np/wp-content/uploads/2016/10/Dairy-Sector-in-Nepal-FAO.pdf

Unit 10
Cleaning and Sanitization

Objectives

On completion of this chapter, the students will be able to know about:

- Cleaning and sanitization of milk utensil on farm
- Cleaning and sanitization of milk plant line in place
- Sanitizing utensil and equipment

Contents

10.1 Cleaning and Sanitization of Milk Utensil on Farm

The milk secreted from cow's udder is usually sterile. It becomes contaminated during and after milking by the milker, milking equipment's, utensils, cooling, storage and while processing. The contamination of milk from improperly cleaned utensils/ cans is about 60%. Good quality milk is essential for production of good quality dairy products. The detergents used for cleaning dairy equipments and utensils are:

a. Alkaline detergents

- Caustic soda (NaOH)- 1 % solution of this can be used
- Sodium bicarbonate (NaHCO3)-1-3% solution
- Trisodium phosphate (Na3Po4) and sodium metasilicate are mixed and use as 1-3% solution for corrosive utensil
- Sodium carbonate and bicarbonate: 1% solution

b. Acid detergents

Acids detergents are used to remove milk stone in dairy utensils and equipments. Nitric acid (0.1%), phosphoric acid (1%), hydroacetic acid and citric acid solution are some of acid detergents used to remove milk stone.

10.2. Milk Utensil on Farm

The essential steps that must be taken during cleaning and sanitation of milk utensils and milking equipment on farms are:

1. Pre-rinsing with Water: Pre-rinsing with cold or lukewarm water should always be carried out immediately upon emptying the vessels. Otherwise, the milk residues will dry and stick to the surfaces, making them harder to clean. If there are dried milk residues on the surface, it may be advantageous to soak the equipment, to soften the dirt and making cleaning more efficient.
2. After rinsing, scrub utensils/pails thoroughly with a suitable brush, using hot water and efficient dairy detergents like, washing soda, tri-sodium phosphate, sodium hydroxide and sodium metasilicate.
3. Then washing is done with hot water. The temperature of water should be more than 50°C.
4. Wash the utensil again with enough cold water to remove traces of detergent.
5. Sanitize the cleaned utensils with acceptable sanitizing agent (iodophors/ chlorine solutions (50-200ppm of active compound)) to kill/disinfect the utensils.
6. Properly cleaned vessels should be placed in inverted position for the complete drainage of water, so as to avoid contamination from air, insects, rodents, reptiles etc.

7. Dry cleaned utensils should be stored in dust, dirt and other contamination protected area.

8. Hot water sterilization- the temperature should be as near the boiling point as possible and never below 85°C. The utensils should be immersed for 20 min, but where it is not possible, boiling water should be poured over the milk-contact surfaces till they are too hot to touch.

10.2 Cleaning and Sanitization of Milk Plant line in place

Cleaning in Place (CIP) can be defined as circulating cleaning liquids or detergent solution through machines, tanks, pipes, process lines and other equipment without the equipment moving from its place. This techniques is used for permanently installed equipments like pipes and tanks, which are practically impossible to clean

by other means.

Cleaning and sanitization of milk plant line in place comprise the following stages

1. Rinsing with warm water for 3 minutes
2. Circulating of a 0.5-1.5% alkaline detergent at 75ºC for about 10 minutes
3. Rinsing with warm water for about 3 minutes
4. Sanitization with hot water 90-95ºC for 5 minutes
5. Gradual cooling with cold tap water for about 10 minutes

10.3 Sanitizing utensil and equipment

It is an attempt to kill most or all of the microorganisms on utensil and equipments surface. Hot water (90-100ºC), flowing steam, steam under pressure, halogens (chlorine or iodine) and quaternary ammonium compound etc. can be used for sanitization of utensils and equipments. Following chlorine concentration is used for the following sanitization purpose:

Bottle: 50-100ppm for 2 minute

Vat/ plate chiller: 100-200ppm for 2-3 minute

Vat/ tanker spray: 205 ppm for 2-3 minute

Butter churn, ice cream freezer: 50-250ppm for 1-2 minute

Learning Process and Support material

a. Visual method
b. Demonstration method
c. Observation method

Teach and allow the students to clean the utensils with milk stone using different detergents.

Show different visual related to cleaning milk utensil on farm and in dairy industry

Support Materials

- Acid detergents
- Alkali detergents

- Utensils with milk stone
- Videos of cleaning milk plant line in place

Assessment

1. Define sanitization.
2. Write down the steps for cleaning and sanitization of milk plant line in place.
3. Write down the steps for cleaning and sanitization of milk utensil on farms.

Glossary

- Milk stone: hard deposit of *milk*residues that accumulates on imperfectly cleansed dairy utensils and serves as a substrate for bacteria and contributes off-flavors to *milk*.
- Corrosive: Causing or tending to cause the gradual destruction of a substance by chemical action
- Luke warm: only moderately warm
- Pails: a usually cylindrical container with a handle
- Disinfect: to free from infection especially by destroying harmful microorganisms

References

Dairy animal management *http://bieap.gov.in*

Unit 11
Manufacture of Dairy Products

Objectives:

On completion of this chapter, the students will be able to know about:

- Importance of milk products
- Methods of preparation of butter and ghee
- Methods of preparation of yoghurt and lassi
- Methods of preparation of chhena and paneer
- Methods of preparation of khoa, cheese, condensed milk
- Method of preparation of milk powder
- Methods of preparation of ice cream and churpi
- Cost of different dairy products
- Legal standardization of different dairy products in Nepal
- Organizations working in dairy sector and their functions

Contents

11.1 Importance of Milk Products

- To increase the nutritive value of milk
- To increase the keeping quality of milk and makes it less susceptible to bacterial growth
- For preservation of milk and nutrient of milk e.g. dry milk
- To increase the delicacy and palatability
- To decrease the economic losses of farmers from milk holiday
- To increase the return above the base price of raw milk

11.2 Methods of preparation of

11.2.1 Preparation of Butter and Ghee

Preparation of Butter

Methods of preparation of butter

Butter is defined as a fat concentrate that is obtained by churning cream, gathering

the fat into a compact mass. It may or may not contain salt.

1. Collection of milk
2. Preheating (35-45 ºC)
3. Cream separation
4. Neutralization of cream (with NaOH, $NaHCO_3$, Na_2CO_3etc)
5. Standardization of cream (35-40% fat)
6. Pasteurization (85 ºC/no hold or 75 ºC/15 sec)
7. Cooling (room temperature)
8. Adding butter culture (1%) and ripening (room temperature for 15-16 hours) it increases flavor
9. Ageing (5-10 ºC for at least 5 hours)
10. Churning: gentle agitation of milk cream at a suitable temperature until the fat globules adhere forming large mass
11. Washing (removes all loosely adhered butter residue and butter curd. It improves keeping quality and reduce off flavor.)
12. Salting (2%): it act as preservatives and taste enhancer
13. Packaging and storage (stored at -23 to -29 ºC)

GHEE

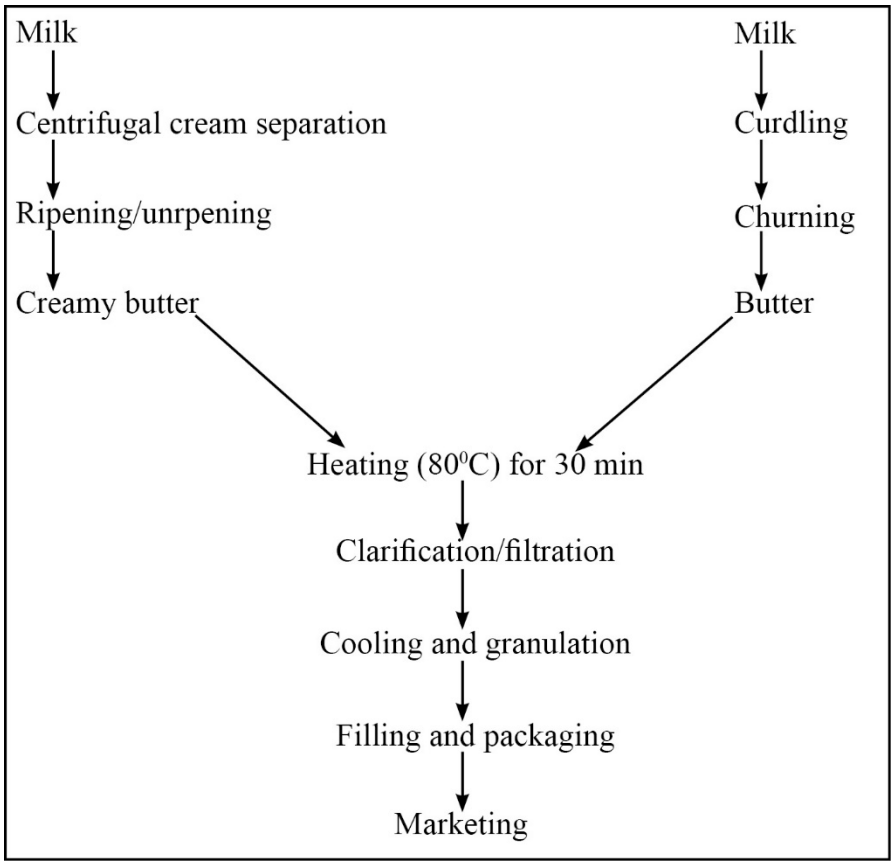
Ghee is a clarified butter fat that is something liquid like consistency by removing unwanted solid matter and impurities.

Manufacturing Process

- Traditional method
- Cream method
- Butter method

In traditional method, milk is first boiled and poured into theki in warm condition for dahi making. Dahi is then churned with household wooden churner (mathani). Nauni is then recovered after churning and butter milk is separated. Warm water may sprinkled during churning for fast recovery of nauni but the fat content is very

low in it. This nauni is then cooked in a vessel. Ghee serum formed on the top layer during cooking is skimmed out. The end point of cooking is determined by sprinkling chilled water on the ghee surface. The cracking sound indicates the end of cooking time. Ghee is transferred into another vessel. There may be ghee residue on the bottom of the vessel after cooking. Then ghee is kept in a cool place.



11.2.2 Preparation of Yoghurt and Lassi

Yoghurt Preparation

Yoghurt is a lactic acid fermented milk product with lactobacillus bulgaicus and streptococcus thermophiles (1:1 or 2:1 ratio)growing together symbiotically. The pleasant aroma of the yoghurt is obtained through the production of lactic acid by the fermentation of lactose content of milk.

Materials required

- Starter culture
- Cow milk/ buffalo mik or mixed milk
- Incubator
- Milk container
- Refrigerator
- Plastic cups/ stainless steel containers

Methods of preparation of Yoghurt

1. Take fresh milk
2. Clarification (removal of dust, dirt, hair follicles, cow dung particles, insects etc.)
3. Standardization (fat≤ 5%, SNF 12-20%)
4. preheating (60 ºC)
5. Homogenization (it increases body texture and taste of the product)
6. Boil the milk at 80-90 ºC for 15-30 min
7. Bring down the temperature of the heat treated milk to 45ºC
8. Inoculate the milk with the starter culture @ 1.0 % (1 % mother culture containing *lactobacillus bulgaricus* and *streptococcus thermophiles*(1:1 or 2:1ratio)
9. Distribute the milk in container (plastic cups/stainless steel containers) of desired capacity and close with the suitable lids.
10. Incubate at 42-45 ºC for 4 hours
11. Take out the dahi containers from the incubator and keep them in refrigerator at 4-5 ºC until use.

Lassi Preparation

The set curd (dahi) is used for the preparation of lassi. The curd is broken either manually (using mathani) or with the help of an agitator and then desired amount of sugar, salt, water and essence is added to get the delicious “lassi” prepared.

Materials required are

- Curd (dahi)
- Homogenizer
- Sugar
- Common salt
- Container (plastic or glass)
- Agitator (mathani)
- Pot (stainless steel)
- Essence
- Incubator

Method for preparation of Lassi

- Take clean raw milk and standardize its fat % to 3.5 to 4.0 %.
- Heat the milk at 80 ºC for 5 minute in the vessel.
- Bring down the temperature of heated milk to 30 ºC.
- Inoculate with an active starter culture of dahi @ 1% taking all septic precautions.
- Incubate the inoculated milk at 30 ºC for 12-15 hour after mixing.
- Take the curd so prepared and break it either manually (with mathani) or mechanically (agitator).
- Add water to get the desired texture of the preparation.
- Add sugar and salt to taste and essence to the desired flavor.
- Mix thoroughly the content with the help of a homogenizer.
- Fill the preparation in the container (plastic or glass) and store in the refrigerator (4-5 ºC) till use.

11.2.3 Chhena and Paneer

Chhena

Chhena is defined as the solid product obtained by the acid coagulation of milk at its boiling point followed by subsequent drainage of whey. The commonly used coagulants are lactic acid or citric acid and or juices of citrus fruits.

Method of Chhena preparation

- Receiving milk
- Clarification/filtering
- Boiling with stirring
- Transfer to coagulating vessel
- Addition of coagulants (lactic or citric)at pH 5.4
- Stirring
- Straining (removal of whey)
- Cooling of chhena

Paneer

Method of paneer preparation

- Whole milk
- Heating in a stainless steel pot till the milk begins to boil. Stir regularly to prevent burning
- Remove from heat
- Add 1 tablespoon of lemon juice or vinegar/liter of milk
- Stir briefly. Curd should begin to form
- Remove the whey by straining through cheese cloth
- Tie the curd in the cheese cloth in to a bundle
- Place a bundle on a plate
- Press the bundle from above with some weight for 4-6 hrs
- Unite the bundle and refrigerate
- Paneer

11.2.4. Khoa, Cheese, Condensed milk

Khoa

Khoa is defined as partially dehydrated whole milk product prepared by the continuous heating of milk in a Karahi over a direct fire.

Method of preparation of Khoa

- Milk receiving

- Filtering/clarification
- Pour into the karahi
- Put over the fire
- Dehydration and stirring by Dabilo(scraper) continuously
- Preparation of Khute (condensed milk)
- Dehydration
- Semi-solid
- Off fire
- Stirring
- Fill in clean and dry container (packaging)
- Labelling
- Store in cool and dry place

CHEESE

Cheese is a product obtained by coagulating the milk in presence of lactic acid produced by lactic acid bacteria with the help of rennet or similar coagulating agents.

Types of cheese

1. Soft chees
2. Semi soft/semi hard cheese
3. Hard cheese
4. Very hard cheese
5. Whey cheese

Method of preparation of cheese

- Pasteurized skim milk with SNF 9%
- Adding 1 ml saturated solution of CaCl per 100 liter of milk
- Adding lactic starter (5-6%)
- Adding rennet (1.5gm/100litre)
- Incubate at 30-32ºC for curd formation
- Cutting with curd knife when whey acidity developed to 0.5% (pH 4.6-4.7)

- Cooking (59 ºC for 2 hours) with gentle agitation so that curd develops elasticity
- Drainage of whey
- Washing the curd with water

  1st wash: 27 ºC for 10 min

  2nd wash: 17 ºC for 10 min

  3rd wash: 8 ºC for 10 min
- Salting (1% of final mass)
- Packaging in wax coated paper or cheese paper
- Storage (5-10 ºC)

11.2.5 Milk powder

Milk product prepared by removal of all the free water from milk by heating or by any other methods is called milk powder or dried milk.

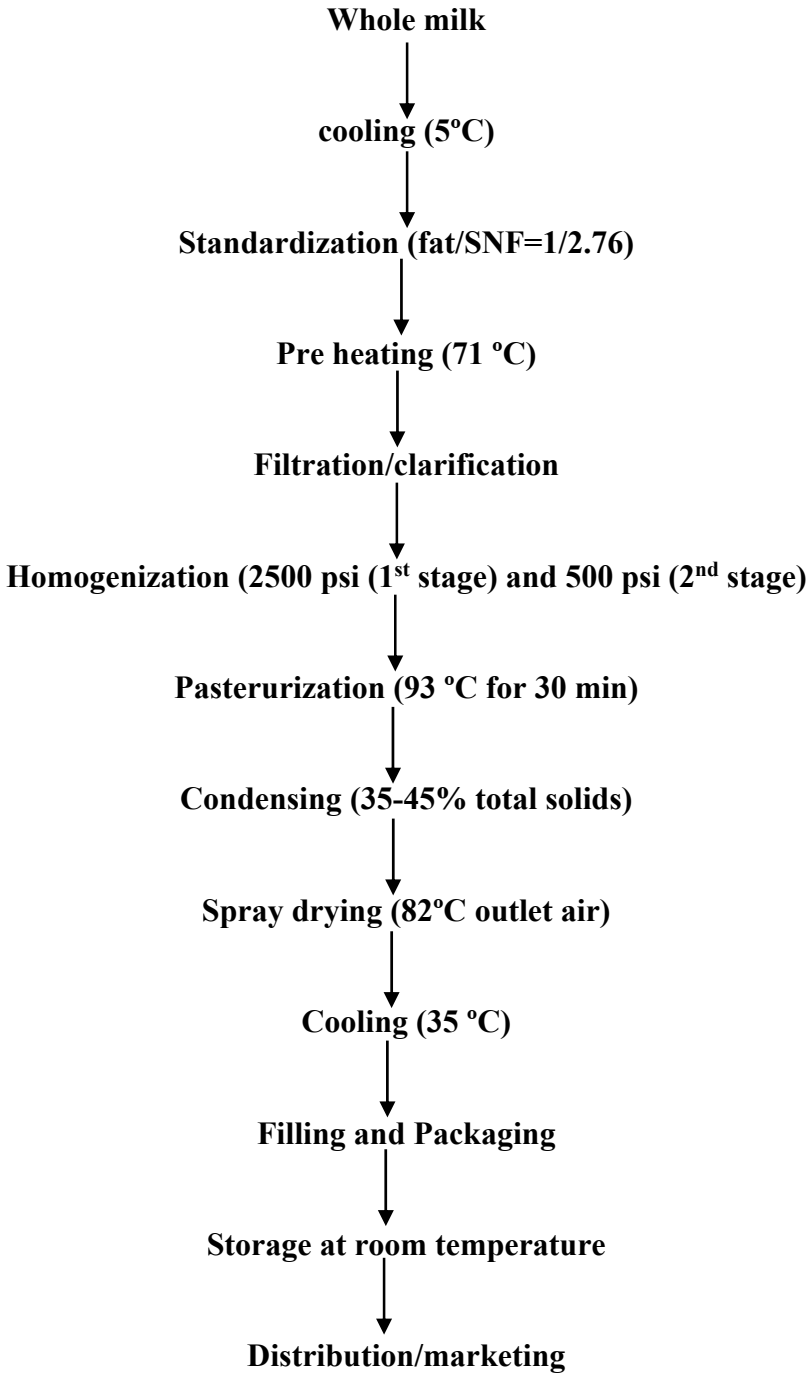
Types of milk powder

- Whole milk powder
- Partially skimmed milk powder
- Skimmed milk powder

Composition

Milk powder	Moisture (%)	Fat (%)	Protein (%)	Lactose (%)	Ash (%)
Whole milk powder	2.0	27.5	26.4	38.2	5.9
Skimmed milk powder	3.0	0.8	35.9	52.3	8.0

Method of preparation of Whole Milk Powder



11.2.5. Preparation of Ice cream and Churpi

Preparation of Ice cream

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

Materials required

a. Ingredients

For manufacturing 1kg ice cream

1. Milk: 650-700ml
2. Cream/ butter: 100gm/50gm
3. skim milk powder: 50-100 gm
4. Sugar: 150 gm
5. sodium alginate :3-4 gm
6. glycerol mono stearate (GSM): 2-4 gm
7. flavors: vanilla, chocolate, strawberry, pine apple, coca powder etc
8. Edible colour (yellow/green/pink)

b. Equipment

Ice cream plant

Method

1. Selection of ingredients (skim milk powder, whole milk, GMS, sodium alginate, cream etc.)
2. Figuring and making the mix (mixing of dry ingredients with milk and cream separately)
3. Pasteurize the so prepared ice cream mix at 71 ºC for 20 min and then cool rapidly it to below 5 ºC.
4. Homogenize the ice cream mix first at 2500 psi and then at 500 psi keeping temperature between 63 to 77 ºC.

5. Cool the mix immediately after homogenization to 0-5 ºC (sodium alginate requires no ageing).
6. Transfer the ice cream mix to the freezer (-4to -5 ºC).
7. Add the proper amount of edible colour and flavouring materials (vanilla essence) to the mix in the freezer where continuous agitation of the mix is in operation in order to incorporate air and quick freezing of the mix.
8. Take out the partially frozen ice-cream from the freezer, transfer in to package (desired containers) and then quickly place in to the cold storage (-23 to -29 ºC) further freezing and hardening without agitation.)

Preparation of Churpi

Durkha or Chhurpi is a milk based food usually made in the mountain region of Nepal. Yak milk is usually preferred to make Dhurkha.

Ingredients

Yak Milk, Lime, butter milk, lemon or anything containing lactic acid

Method

- Boil Milk
- Add key lime, fitkiri (Alum), Mohi (buttermilk) or any other sour fruits juice as lactic acid to the milk.
- Stir the boiling milk continuously with strong wooden stirrer Kelu.
- As the milk start boiling a thick layer of butter starts to form in the milk. Extract the butters and it keep aside (it is not used to make durkha) while let the milk boiling continuously.
- After 2 to 3 hours of boiling the milk, white cheese starts forming. Separate this white cheese with the help of large bamboo sieve called Chergang and spread in the separate piece of cotton cloth.
- Tie the cloth and press hard to drain excess water out. (few hours of draining makes the cheese hard)
- Cut the cheese into small pieces and dry under the sun or in shade or over a wood fire oven.
- When it get dried, the product is Durkha or chhurpi.

- This type of Chhurpi becomes very hard and having low moisture content. These durkha or churpi can be stored for a number of years.

11.3 Cost of Different Dairy Products

S.No.	Product	Price (Rs.)	S.No.	Product	Price (Rs.)
1.	Pasteurized Milk	75/lt	2.	Nestle Milk Powder	400/ 400gm
3.	DDC Yak Cheese	565/500gm	4.	Local Cheese	578/500gm
5.	Ghee (Local)	750/lt	6.	Ghee (Dairies)	900 / lt
7.	Yoghurt	180/lt			

11.4 Legal Standardization of Different Dairy Products in Nepal

The Nepalese legal standards of dairy products are given below in tables:

Types of dairy product	% Fat (min)	% SNF (min)
Cow milk (whole)	3.5	7.5
Buffalo milk (whole)	5.0	8.0
Processed milk	3.0	8.0
Evaporated milk	7.8	25.9
Evaporated skimmed milk	-	20.0
Sweeten condensed milk	8.0	28.0
Skimmed sweetened condensed milk	-	24.0
Partly skimmed sweetened condensed milk	3-9.0	28.0

Source: The Nepal Gazette 2057 (no. 42) part 3

11.5 Organizations working in dairy sector and their function

Organizations working in dairy sector are:

1. Dairy cooperatives
2. Dairy development corporation
3. National dairy development board (NDDB)
4. Department of livestock services (DLS)
5. Department of food technology and quality control (DFTQC)

6. Department of co-operatives
7. National cooperatives Development Board (NCDB)
8. Private sector(Nepal Dairy, Himalaya Dairy, Sitaram Dairy,Anmol Dairy, Kathmandu Dairy, Adhunik Dairy etc. in Kathmandu valley; Sujal Dairy in Pokhara Valley and Kamdhenu dairy in Sunsari)

Their functions are:

- The dairies produce pasteurized milk and other dairy products such as yoghurt, ice-cream, butter, ghee etc. Similarly, some private entrepreneurs have also involved in producing cheese in the mid and high mountain regions from cow and nak milk.
- Help in operating milk chilling vats
- Help in increasing production and processing of milk and milk products and to contribute to the financial and social upliftment of the rural milk producers
- To provide a guaranteed market for milk to the rural farmers with fair price
- To supply pasteurized milk and milk products to urban consumers
- To develop organized milk collection system to meet increasing demand for pasteurized milk and milk products
- To develop an organized marketing system for milk and milk products in urban areas.
- Formulation and recommendation of milk pricing policy to the Government
- Recommendation to Government on well-being of dairy processors and consumers, Development of cooperative sector dairies, Registration of dairy industries
- Management and mobilization of national and foreign grant and loan for dairy industries
- To promote entrepreneurship by developing and disseminating appropriate technologies and improve the nutritional status of people through food based approaches
- Registration of cooperatives, making recommendations for improvement of cooperatives and dissolving such cooperatives which acts are against its objectives

Learning Process and Support material

a. Visual method

b. Demonstration method

c. Observation method

- Teach the student about methods of preparation of different dairy products in school.
- Show Videos of preparation of different dairy products
- Visit students to different dairy industry

Support Material

- Videos
- Different ingredients for preparing different dairy products

Assessment

1. Define the terms (4×1)
   a. Ghee *b. milk powder* *c. Chhena* *d. Butter*
2. Enlist the organization working in dairy sector.
3. Explain the process of manufacturing ghee.
4. Explain the process of manufacturing of paneer.

Glossary

Ripening: coming to full development

Churning: a container or machine in which cream or milk is agitated to make butter

Coagulating agent: agent which is added to a vessel to help thicken something

Dehydration: the loss or removal of water from something.

Whey: the watery part of milk that remains after the formation of curds.

Essence: an extract or concentrate obtained from a plant or other matter and used for flavoring or scent

References

- Preparation of dairy products by Pauline Abing and Karin Rutgers
- Introduction to Dairy Science and Technology
  http://www.foodsci.uoguelph.ca/dairyedu/home.html