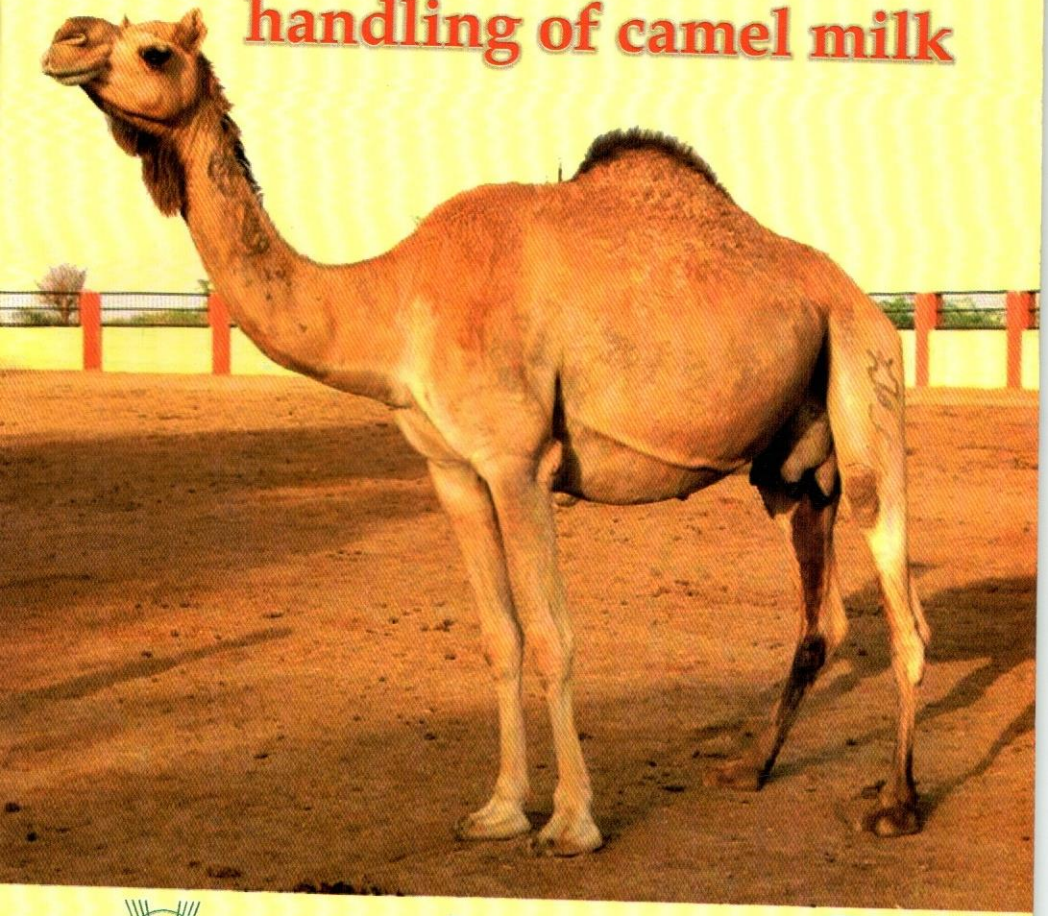
Hygienic production and handling of camel milk



भाकृअनुप-राष्ट्रीय उष्ट्र अनुसंधान केन्द्र

ICAR-National Research Centre on Camel

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PREFACE

ICAR-National Research Centre on Camel (NRCC) has played an important role in advancing the frontiers of Science and Technology in Camel Research. In the recent years, due to continuous efforts of NRCC, the Food Safety and Standard Authority of India has recommended the operational standards for camel milk. The health benefits of camel milk was also explored at the centre in collaboration with various medical and other research agencies. The clean and healthy milk plays important role in human nutrition. The contaminated/unhealthy milk may possess threats to consumers. Milk is full of easily available nutrients required for microbes to grow and multiply. Therefore, proper care is needed for hygienic production of milk. The milk can be contaminated at various points of production, handling and transportation, which can be minimized by educating the animal handlers, milk processors, transporters and sellers. The consumers awareness is also required to avoid contamination and spoilage of milk at their home.

The scientists of ICAR-NRCC has compiled the publication titled "***Hygienic production andhandling of camel milk***" and I appreciate the efforts of Scientists for bringing out this publication. Finally, I hope that this publication will be useful to camel milk producers, processors, consumers and students of concerned disciplines.

(N. V. Patil)
Director

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Introduction

The camel is an important livestock of desert ecosystem, a proven icon of adaptation with its unique bio-physiological characteristics with formidable ways of living in harsh situations of arid and semi-arid regions. The proverbial *"Ship of Desert"* earned its epithet on account of its indispensability as a mode of transportation and draught ability in desert. The camel has also played a significant role in civil law and order, defense and battles from the ancient times till date. However, its efficient utilities are subject to continuous social and economic changes.

The global camel population is estimated to be around 27 million, spreads across 47 countries. About 83 per cent of the camel population inhabits mainly the eastern and northern Africa and rest inhabits the Indian subcontinent

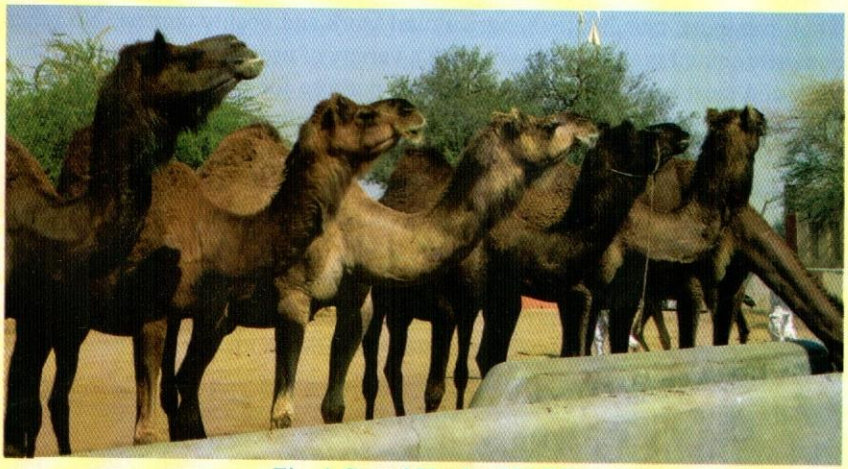

Fig. 1 Camel Herd at NRCC

and Middle East. Somalia has the highest population of 7.10 million and India stands tenth in the world with 0.38 million camels. In last five decades, the world's camel population increased by about two folds due to nearly three folds increase in the Africa region, while it recorded a decreasing trend in the Asian region including India. This might be due to declining trend in use of animals in agricultural and transport works and less demand of camel milk and other products in these countries. One most important reason of increasing camel population in African region is the demand of camel milk and meat.

Out of the total camel population in world, 89% are one-humped dromedary *(Camelus dromedarius)* and remaining 11% are the two-humped bactrian *(Camelus bactrianus)*. In India, the total population of is 0.4 million

(DAHDF, 2014) accounts for 0.08% of total livestock population. The population of Indian camel is mainly confined to the States of Rajasthan (81.4%), Gujarat (7.6%), Haryana (4.7%), Bihar (2.2%), and Uttar Pradesh (2.0%). Major reduction in the population has been during the last two decades when the population of camel reduced from 0.9 to 0.4 million. The main reasons for the continuous decline in camel population in India are significant reduction in the traditional use of camels for draught purpose for transport of goods including agricultural material, use in agriculture and the shrinkage of range lands. Some other causes for the decline in camel population are the increasing trend in adoption of intensive agricultural practices for cash crops due to the availability of canal water in the Thar-desert and emergence and re-emergence of new camel diseases. The camel has many unique qualities to survive and serve under harsh climate and utilize low quality feed resources, which other species cannot consume. The camel is a multipurpose animal and can be used for milk, meat, wool, transport, race, tourism, agricultural work and beauty contest. No other domestic animal is able to provide such a variety of uses to human populations. Milk and meat production is the principal purpose for camel rearing in many countries, especially for one humped camel. The quality of camel wool is widely variable. It is better in countries having cold winters and Bactrian wool is more appreciated. The camel is also used in tourism for riding/safari and racing. The camel race is an important cultural event in many countries including India. Historically these animals were also utilized by armies, and today a number of countries still using camels for their military campaigns. Camel power is used primarily for peaceful means for transport. Draught camels are common in India for transportation of all kinds of industrial or agricultural goods. The camel is also an auxiliary of agricultural activities for ploughing, water extraction, seeding, harrowing etc. The use of camel as tourist attraction is developing, not only for riding on dunes beach, or other tourist places, but also for festivals, marriage ceremony, fantasia and other spectacles like the dancing camel at Animal fairs in India.

Traditionally, camel was mainly utilized as a draught animal in agriculture and transportation. However, now the stress on camel husbandry practices has shifted towards promotion of camel as a milch animal.

The importance and use of milk from non-bovine animals is growing worldwide not only in terms of quantity (15% of global milk production) but also in terms of therapeutic potential, cultural, economic, and ecological interest. Special nutritional and therapeutic characteristics have been claimed for certain non-bovine milk and milk products. These underutilized sources are of potential importance to milk producers, milk processors and consumers around the world. Among these non-bovine animals, camel plays an important role in desert

ecosystem, with its unique characteristics and adaptability; it can survive in harsh situations of arid and semi-arid regions. It has a very good milk production potential with a compositional and functional uniqueness.

Camel milk has an important role in human nutrition in the hot and arid regions of the world. This milk contains all the essential nutrients as found in other milk. Fresh and fermented camel milk has been used across the world including India for human consumption and for treatment of a series of diseases such as dropsy, jaundice, tuberculosis, asthma and leishmaniasis or kala-azar. Recently, camel milk and its components were also reported to have other potential therapeutic properties such as anti-carcinogenic anti-diabetic, anti-hypertensive and reno-protective potential, and has been recommended to be consumed by children who are allergic to bovine milk. It has also been reported to alleviate oxidative stress and lipid peroxidation in experimental animals.

The hygiene plays an important role in production and marketing of healthy milk to safeguard the human consumer from food born infections and intoxication. Many pathogens could be transmitted through contaminated milk. Milk also serves as a very good medium for growth and survival of bacteria. Therefore, it becomes very much essential to follow all the hygienic protocols at every step of production, transportation and marketing for providing healthy milk to consumer.

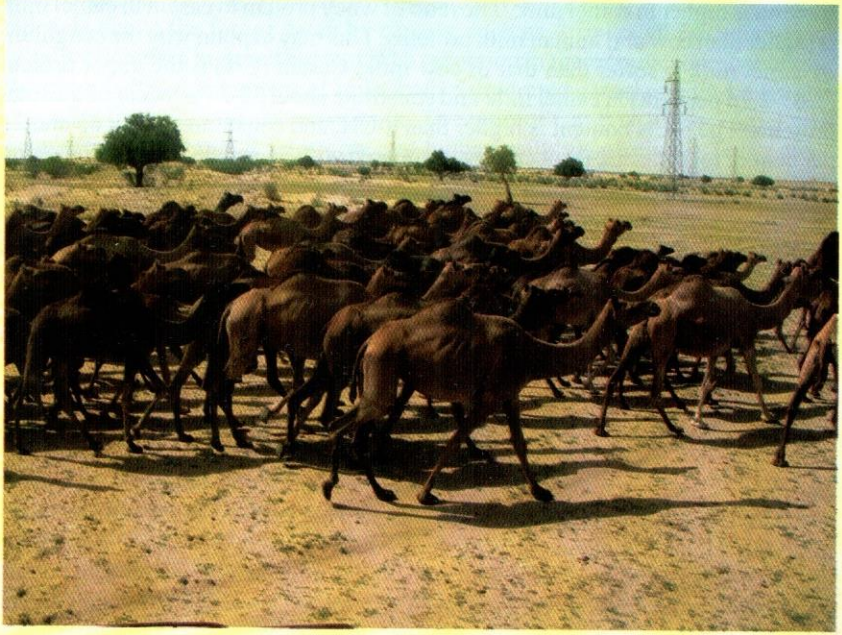

Fig. 2 Camel herd going for grazing

Camel Milk : properties and health benefits

Camel milk is generally opaque white in color, foamy and slightly salty to taste. This may be due to feeding on certain shrubs and herbs in the arid region. The average density of camel milk is 1.029 g/ cm^3 and has been reported to be less viscous than bovine milk. The pH of fresh camel milk ranges from 6.4 to 6.7. The freezing point of camel milk is between -0.57 and -0.61°C. The camel milk has lower calorific value (665 Kcal/L) as compared to cow milk (701 Kcal/L). Camel milk composition and nutritive value Camel milk composition was found to be less stable than other species such as bovine milk. However, variations observed in camel milk composition could be attributed to several factors such as analytical measurement procedures, geographical locations, feeding conditions and samples being taken from different breeds, in addition to other factors including stage of lactation, age and calving number. Geographical origin and seasonal variations were found to be the most effective factors in camel milk composition.

The water content varies from 87-90 per cent in camel milk. An inverse relationship was found between total solids in camel milk and water intake by camels.

Milk proteins

Total protein content of camel milk ranges from 2.15 to 4.90 per cent. Casein content of camel and cow milk is quite similar; however, the whey protein fraction is higher in camel milk. The ratio of whey protein to casein in camel milk is higher than cow and human milk proteins. This may explain why the coagulum of camel milk is softer than that of cow milk. Casein (CN) is the major protein (1.63-2.76 per cent) in camel milk and constitute about 52-87 per cent of the total proteins. The β-CN content is higher than α-CN, and constitutes about 65 and 21 per cent of total casein, respectively, compared with 36 and 38 per cent in bovine milk, respectively. The κ-casein content of camel milk is about 3.47 per cent of the total casein compared to 13 per cent in bovine milk.

Whey proteins constitute about 20-25 per cent of the total proteins and 0.63 and 0.80 per cent of the milk. Of the two major whey proteins, α-lactalbumin is the main component in camel milk and β-lactoglobulin is deficient. Other whey proteins present in camel milk are serum albumin, lactoferrin, immunoglobulins and peptidoglycan recognition protein.

Milk fats

The fat content of camel milk ranges between 1.2 to 4.5 per cent depending upon the level of nutrition, stage of lactation, breed, season, etc. Camel milk fat is characterized by higher proportion of unsaturated fatty acids compared with other species. This may the main reason for waxy texture of camel milk fat. Higher contents of long-chain fatty acids were also reported for dromedary camel milk fat compared with bovine milk fat. Compared with bovine milk, camel milk has a lower content of carotene. This lower carotene content

could explain the whiter color of camel milk fat.

Table 1 : Chemical composition of camel and cow milk

Constituents	Camel milk	Cow milk
Water (%)	88.5-91.0	85.5-87.5
Total solids (%)	9.0-11.5	12.5-14.5
SNF (%)	7.5-8.5	9.5-10.5
Fat (%)	1.2-3.5	3.0-4.5
Protein (%)	2.15-4.90	3.2-3.5
Lactose (%)	3.5-4.5	4.0-4.5
Total ash (%)	0.60-0.80	0.7-0.75
Insulin (μU/ml)	40.5	16.3
Lactoferrin (mg/ml)	2.5	0.5
Vitamin C (mg %)	5.3	1.0

Lactose

The lactose content of camel milk remains almost unchanged over a season and under hydrated or dehydrated conditions and it ranges between 3.5-4.5 per cent.

Mineral content

The total mineral content of camel milk varies from 0.60 to 0.90 per cent. Camel milk is rich in Zn, Fe, Cu and Mn and richer in Cu and Fe than cow milk. The concentration of other major mineral Ca, Mg, P, Na and K in camel milk is almost similar to those of cow milk. Camel milk is a rich source of chloride due to the forage eaten by camels, such as Atriplex and Acacia, which usually contains a high salt content. The reduction in major milk components and increase in chloride content of milk from dehydrated camels might be another cause for the salty taste in camel milk. The ratio of Ca: P is 1.5 for camel milk compared to 1.29 and 2.1 for cow and human milk, respectively. This ratio is important, as the cow milk-based formula used for feeding infants contains high phosphate; this may lead to hyperphosphatemia and low serum calcium.

Vitamins

Among water-soluble vitamins, camel milk is richer in niacin and vitamin C than cow milk. Vitamin B1, B2, folic acid and pantothenic acid are low in camel milk; B6 and B12 content are quite similar to that of cow milk and higher than human milk. The content of vitamin A camel milk is reported to be lower than that of bovine milk and it ranges between 100-380 μg/L.

According to the USDA (2009), camel milk (250 ml) provides an adult with about 15.5 per cent of cobalamin (Vit B12), 8.25 per cent of riboflavin (B2), 5.25 per cent of vitamin A and 10.5 per cent of ascorbic acid (Vit C), thiamin (Vit B1) and pyridoxine (B6) of the recommended daily intake.

Medicinal values and functionality of Camel milk

Milk is considered as a complete food for mammal's neonates because it provides the complete nutritional requirement of each corresponding species. It

also contains components that provide critical nutritive elements, immunological protection, and biologically active substances to both neonates and adults.

Fresh and fermented milk has been reported to have stronger antimicrobial and antibacterial activities. Antibacterial activity of camel milk is due to the presence of antimicrobial substances such as lysozyme, hydrogen peroxide, lactoferrin, lactoperoxidase and immunoglobulins. Camel milk was reported to have an antimicrobial effect against Gram positive and Gram negative bacteria, including *Escherichia coli, Listeria monocytogenes, Staphylococcus aureus* and *Salmonella typhimurium.*

When milk is fermented with a specific bacteria - Lactobacillus helveticus, the peptides generated by protein hydrolysis has been shown to have potential ACE-inhibitory activity which interns helps in blood pressure regulation in human beings. Fermented camel milk (Gariss) and Gariss containing *Bifidobacterium lactis* (BB-12) administration have been reported to possess a hypocholesterolaemic effect in-vivo in rats.

Presence of high concentration of insulin/insulin like substances in camel milk such as half-cystine, the effect of small size immunoglobulins of camel milk on β-cell and the lack of coagulation of camel milk in the human stomach, contributes to the hypoglycaemic effect in type-1 diabetes. The studies have been conducted in laboratory animals- rats and dogs, and also in human beings by clinical trials by various scientists.

Camel milk is also suggested as a food alternative to children with allergenicity to bovine milk. Hypoallergenicity of mothers' milk was reported to be due to the high percentage of β-casein, low percentage of α-CN, deficiency of b-lactoglobulin and similarity of the immunoglobulins.

Consumption of camel milk in autistic children has also resulted in significant improvement in their behavior and disease resistance.

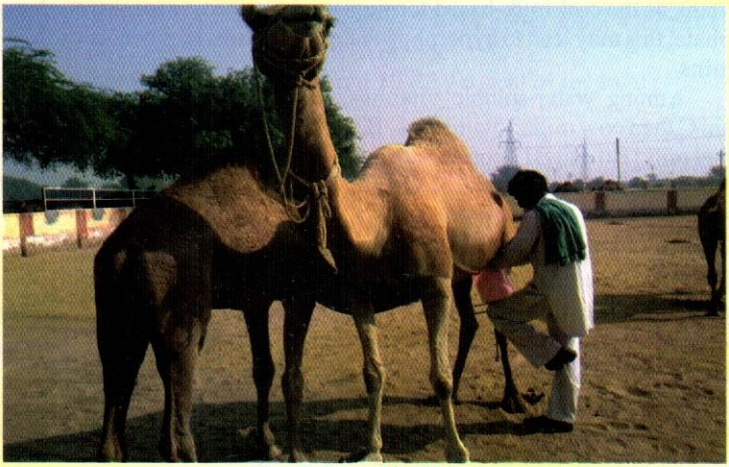

Fig. 3 Camel Milking

Qualities of clean and healthy milk

Healthy milk comes from clean and healthy animals and milkers. Unattractive taste of the milk is usually observed when milk is drawn from sick animals. If an animal has been treated with antibiotics or other drugs, the milk produced by the animal may be harmful to consumers, so withdrawal instructions must be followed. The falling of extraneous matters must be avoided to ensure clean milk production.

Characteristics of good quality milk

- It should have normal taste: may be slightly salty or sweet
- It should smell fresh and pleasing
- It should appear clean
- Must be free from contamination such as dirt/dust etc.
- It should be free of antibiotics and other chemical residues
- Should be stored in clean and attractive containers
- Must not carry any pathogenic organisms

Abnormal taste of milk:

Clean healthy camel milk has a fresh, clean, slightly salty sweet taste, which is highly preferred by customers.

Bitter taste can be caused by:

- Camels browsing bitter herbs and tree leaves
- Sometimes, camel in late lactation produces milk with more salty and may taste slightly bitter.

Unclean (various sheds of rotten) taste may be caused by

- Dirt in the milk may be soil, dung, hairs etc.
- Mastitis milk which may have unpleasant flavor.

Abnormal smell in milk:

Fresh clean milk smells fresh and clean and boiled milk has its own aroma.

Unpleasant smell can be caused by

- Contamination with dirt/dung (manure like smell)
- Mastitis milk can give a slightly sickly smell
- Acaricide that is applied to the udder for tick control: contributes to off flavor and may also lead to food poisoning.
- Spoiled milk: various spoilage bacteria may be involved producing various odors.
- Sour smell is caused by fermentation of the milk. This can be pleasant or unpleasant depending on consumer preference.

Healthy milk

Healthy milk does not pose a threat to consumers. Thus, healthy milk is free from the diseases transmitted to humans through camel milk.

Milk is a near perfect food for humans, animals as well as microorganisms. It can transfer disease causing organisms from animal or person/milker/handler to customers if not boiled or pasteurized. The following are the list of diseases that can be transmitted to consumer through contaminated milk:

- Brucellosis
- Tuberculosis (TB)
- Cholera
- Typhoid
- Scarlet fever
- Diphtheria
- Dysentery
- Q-fever

Brucellosis and Tuberculosis can be transmitted through uterine discharge and urine which may contaminate milk and milker's hand. A milker should therefore, not touch urine, retained placenta or aborted foetus as these can transmit Brucellosis and TB.

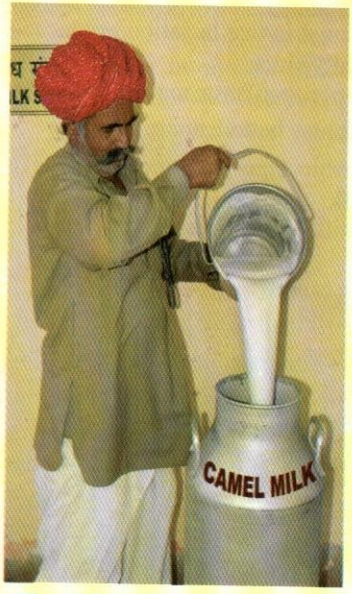

Fig. 4 Camel Milk Collection

Sources of contamination

Milk is the main product from a dairy business, which is directly used as a food for human consumption after some kind of primary processing. Therefore, a dairy farmer must maintain clean and hygienic conditions in the farm as well as milking premises. From public's health point of view, milk is a very good media for bacterial and other micro-organisms development. Therefore, proper handling and storage also becomes an important part of clean milk production. The milk when secreted in udder is sterile but may get contaminated from various sources including animal and udder environment, milkers, utensils etc.

The milking animal:

The animal's hind quarter and udder parts may get soiled from dump floor or the dungs, hence need to be cleaned before milking to reduce the chances of falling these adhered materials into milk while milking process. For pastoralists in dry areas where no clean water is available for washing of udders, wiping with clean dry cloths and hands can reduce the chance of contamination. In areas where clean water is available or in organized camel diaries, water should be boiled or disinfected with chlorine and used for washing the udders before milking. Also, hairs from the animals coat or dribbles from the mouth of the calf may fall into the milk. Dry scabs or scales of skin especially from animals with skin problems may be another source of contamination.

The inside of the udder mainly teat canal may also carry germs, which can come into milk. Usually the first strip has higher bacterial count as compared to the last strip. Mastitis is another condition where the bacterial counts increases in milk, however, in camel cases of acute mastitis are very rare but they can have chronic mastitis, which can only be detected by laboratory tests.

The milker/ human sources:

The persons involved in milking and handling of raw milk can be a source of milk contamination. He or she may be sick, or may carry dirt from elsewhere that can contaminate milk. Sick people, especially suffering from diarrhea, TB or typhoid or having hand injuries should get medical treatment and not resume milking until they are fully recovered. The person milking animals should never touch urine, retained placenta or aborted calves, as these can all transmit Brucellosis and/or TB both to the milker and consumer. The milker should not have long nails, and they should not smoke, sneeze or cough in milking premises.

The environment in milking parlour:

Dust and light manure particles may get blown into the milk when milking is carried out in animal shed or dirty milking parlour. To reduce such type of contamination, milking can be practiced in clean place especially in milking parlour after cleaning and sweeping of flour of milking area. In case of strong wind, a closed areas may be selected for milking purpose to avoid dirts, flies and other insects. A permanent milking shed may be made where provision of clean water must be provided. It should be cleaned after every milking.

The milking equipment

The equipments and utensils use for milking, storage and transportation of milk may act as a major source of contamination if not well cleaned and sanitized. The number of utensils used to handle milk between milking and sale to customers should be minimized, because the more handling equipment the more sources of contamination. The seamless utensils preferably made of aluminium or stainless steel should be used because it is easy to clean and sanitize these utensils. Regular cleaning practice should be followed using scrub with a brush using hot water mixed with a detergent. The utensils must be dried before reuse.

Udder health and milk quality

In case of dairy animals, the udder health plays an important role in clean milk production. There are many conditions, which affects udder of lactating animals, but mastitis is the most important one that not only affects the milk quality but also the production performance of the animal and even the entire herd due to contagious nature of the disease. Camel udder differs from all other lactating animal in that they have two or more teat canals in every teat. This is probably another adaptation to their environment - even if one is spoiled, others are there to produce milk for the calf. But, it poses a challenge in mastitis treatment and control, as the preparations available for mastitis in cows cannot be used in camels.

Mastitis

As the name implies, it is an inflammatory condition of one or more teat canal and the udder of lactating mammals. Camel, as compared to other dairy animals, are less susceptible for mastitis, might be because of antimicrobial substances present in camel milk. The main cause of mastitis is poor management, which may include unclean milkers hand, dirty animal bedding, manure getting into contact with udder, flies etc. Another factor that predisposes the animals to mastitis is traumatic injuries (wound). This can be caused by poor milking techniques, ticks or by thorn scratches.

Mastitis not only reduces the milk yield of lactating animals, sometimes whole quarters of udder dry up. It also negatively affects the milk quality, taste and self life. A small addition of mastitic milk to clean/healthy milk will make it to acquire a very bitter taste, which can't be removed by boiling.

Many types of germs can cause mastitis including Staphylococcus aureus which also causes hair loss and rough hair coat in camels. So, milkers should not wipe hands with the hair coat of the camel before or after milking. Care should be taken not to mix mastitic milk with clean milk. Always wash hands before milking of different individual animals.

For mastitis prevention and control, one need to boost animal's immune systems against mastitis with a combination of good feeding practices and very good hygiene and culling of susceptible / infected animals. The healthy animals should be milked first and the affected animal last to avoid carrying the disease to healthy animals. The frequesnt emptying of udder of affected animals must be done to control mastitis. The ready-made syringes containing various antibiotics are available in market, but because of much narrower teat canals, it is not always possible to use them in camel. Use of certain other devices to introduce drugs into milk canal may be beneficial along with parenteral administration of antibiotic to treat acute mastitis cases.

Mastitis symptoms (such as clotting of milk) are only visible in camel milk in very advanced stages. Early stages can be suspected if the camel kicks when one or more teats are touched (pain symptom), the udder is hot and the skin over the quarter seems tight even after milking. To detect the cases of sub clinical mastitis in herd, periodic screening must be done applying following tests:

1. California mastitis test (CMT)

The milk sample (2 to 5 ml) to be tested is put into cup of the CMT paddle. Then CMT reagent (Table 2) is added in equal volume and paddle is rotated in a circular fashion and the reaction is observed within 10 seconds (Fig 5). The mixture in mastitis positive cases turns greenish blue and thick gel, the degree of changes depends upon severity of the mastitis (Table 3).

Table 2. Composition of CMT reagent

Chemical	Quantity
Sodium hydroxide	1.5 g
Teepol/ Geepol (Liquid detergent)	0.5 ml
Bromothyol blue	0.01 g
Distilled water	100 ml

Table 3. Scoring in California Mastitis Test

Observation in paddle	CMT	Interpretation
The mixture remains liquid and homogenous. It can drip out of the paddle well	0	Normal milk
There is some thickening. The reaction is reversible and the viscosity first observed tends to disappear	T	Trace, it may be normal in late stage of lactation, Check bacterial count of milk sample.
The mixture thickens but there is no gel formation. The viscosity tends to persist. The thickened mixture still pours out gradually	1	Check for sub - clinical mastitis
Gel formation in the middle of paddle. The gel tends to adhere bottom of the well. While pouring the mixture, the gelatinous mass falls out and may leave some liquid well	2	Clinical mastitis (Fig 6)
Gel is formed in the middle of the paddle well, sticking to the bottom. When pouring out the mixture, it falls out without leaving liquid behind	3	Clinical mastitis in advance stage

2. BTB paper test

There are four different saffron coloured spots on the paper, few drops of milk samples from left fore (LF), left hind (LH), right fore (RF) and right hind (RH) quarter are to be poured separately on these coloured spots and change in colour is noted. In negative case, the colour remains unchanged, but in positive case it turns greenish blue (Fig 7). The test is based on the principle that pH of milk rises in mastitis.

3. White side test:

Put a drop of 4% sodium hydroxide solution on a clean glass slide and add one drop of milk sample. Mix them with the help of a toothpick. Thickening of the mixture indicates mastitis.

4. Somatic Cell Counting (SCC)

Somatic cells are present in the milk but their number increases during mastitis. SCC is considered as a sensitive test for early diagnosis of clinical and subclinical mastitis. In this test, 0.01 ml milk sample is spread over an area of 1 cm^2 on a clean glass slide. The smear is fixed by gentle heating and stained with Newman's stain for two minutes. Somatic cells are counted under oil immersion (X100) using a compound microscope and number of cells per ml of milk is determined using the following equation:

SCC = (no. of somatic cells counted X MF)/ No. of fields counted

Microscopic factor (MF) = 40000/ (3.1416 X d^2), where d is diameter of microscopic lens under oil immersion lens. A somatic cell count greater than 306000 should be considered abnormal in camel.

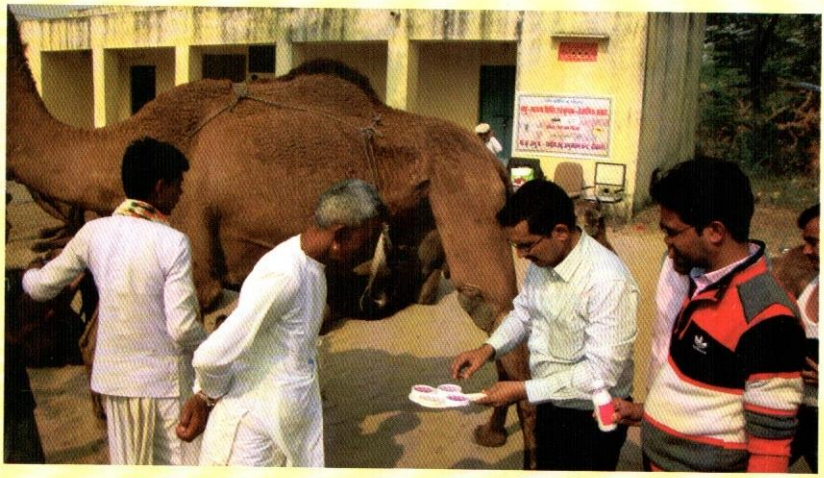

Fig 5. Field demonstration of California Mastitis Test

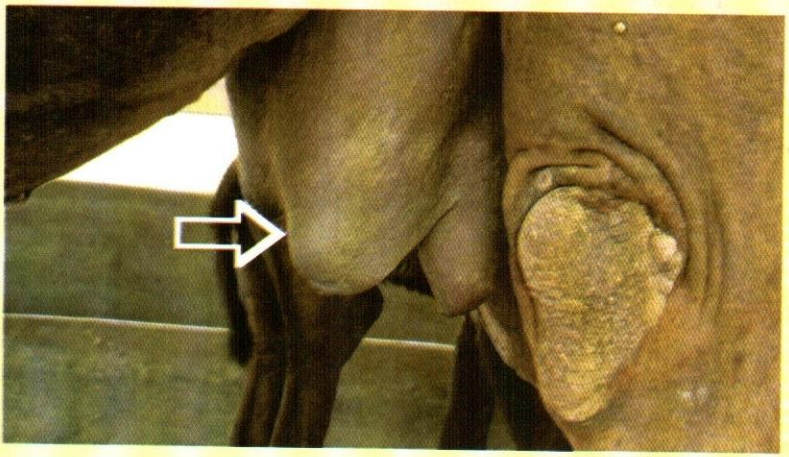

Fig 6. Udder quarter showing clinical signs of mastitis (arrow mark)

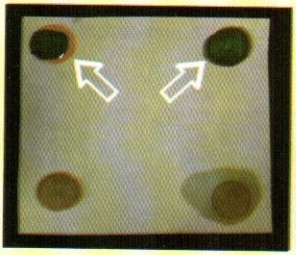

Fig 7. BTB paper test, arrow marks indicate sample positive for mastitis

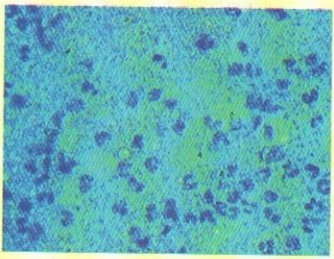

Fig 8. Somatic cells in milk of a camel suffering from clinical mastitis

Clean milk production and handling

Milk is a sterile product when secreted in the udder of a healthy animal. Due to its susceptibility to microbial spoilage, there is a need to adopt clean milk production principles.

Importance of clean milk production:

- Consumers will reject dirty milk at the market leading to the economic loss. It may also affect the reputation if the quality issues persist.
- Dirty milk is extremely difficult to handle because of its short shelf life.
- Contaminated milk is a rich medium for the transmission of food borne and zoonotic diseases. Cross contamination with such conditions such as mastitis will reduce productivity at the farm.
- Clean milk helps in controlling the spread of infectious diseases like Tuberculosis, Brucellosis etc.

Previous chapters describe about the healthy milk and sources of contamination at different level of handling. Now, the steps to be followed to achieve the target of producing clean milk will be discussed.

Personal hygiene:

- Wash your hands and nails with clean water and soap before milking and handling the milk.
- Wear clean over-clothes and gumboots while handling milk
- Never handle milk if you are suffering from a communicable/ infected disease or have an open sore or wound on your arms, hands, head or neck.
- Do not cough or sneeze near milk or milk containers.
- Bathe or take a shower regularly.

Handling at milking level:

Animals should be milked at the same time every day. Before milking, use post-teat dip disinfectant sodium hypochlorite (commonly known as bleach) at about 4% concentration, i.e. 1 teaspoon of bleaching powder in 10 tablespoons of clean water. Washing the udder not only makes it clean, but also stimulates milk let-down.

- Milk all healthy animals in a clean and well maintained milking parlour.
- Maintain clean and healthy animals. The unhealthy animals should be milked last and milk should not be mixed in pooled milk.
- Use suitable sterilized/sterilized containers/equipments for milking. All milk handling equipment must be made from food grade material. Make sure that equipment on your farm meets the following conditions.
- Food-grade materials are safe and can be used for storing and transporting milk and other food products.

- Equipment should not be made of copper or any copper alloy or any toxic material. Copper causes the milk to oxidize; it develops a bad flavor and becomes rancid.
- Equipment should have a smooth finish, wide opening without cracks or rust stains.
- Animal handlers/milkers must be healthy and maintain good personal hygiene and should wear clean cloths when milk and handling of milk.
- After milk collection, the milk containers must be kept covered in cool and dry place to avoid contamination. Preferably, milk should be transferred to bulk milk cooler as early as possible.
- Transport containers must be cleaned and sterilized each day before using it.
- If long transport is needed, always transport the raw milk in cooled conditions. It will be better to get the milk pasteurized and then transport for long distance in cold conditions for extended shelf life.

Handling of milk at bulking/ storage level:

At this stage, all precaution must be taken to avoid contamination of milk using unclean/dirty storage containers, because at this level milk is retained/stored for longer duration, may be for transportation or marketing.

- Clean the bulking containers very well. Pour some boiling water into it and swish it around till all corners have been sterilized. Pour the water out. The container's lids should also be sterilized in the same manner.
- Store boiled or pasteurized milk and raw milk in separate containers to avoid cross contamination.
- Boiled milk should be cooled in storage containers.
- All unprocessed milk awaiting transportation should be kept as cold as possible- under shade, etc.

Proper milk cooling is essential to ensure good quality. Bacteria multiply rapidly when milk is cooled too slowly or if it is stored at a temperature above 4°C. Fresh milk temperature immediately after milking, is about 33°C. Cool the milk immediately, and keep it as cold as possible before processing. The best temperature for storing milk is 2° to 4°C. Cooling is very important, especially if time gap between milking and delivery at the collection center is more than 2 hours. In such cases, ideal storage temperature will be 1-2°C. Cooling should be done in two stages. First, fresh milk is pre-cooled to 15-20°C or lower. Then, it will be cooled to storage temperature. For any subsequent milk (arriving in batches) the mixed or blended temperature should not go above 10°C.

Handling of milk during transportation:

Milk is generally transported from producers to processors to consumers. However, in many cases milk is directly supplied to consumer by

producers with or without processing. In that case, the producers must be aware of hygienic handling and transportation of milk. Because milk is a highly perishable product, transporters must ensure high levels of hygiene, speedy transport and careful handling. This will minimize losses due to spillage and spoilage, avoid contamination of milk by pathogens, and also increases the profits from your milk transportation business. Some of the important issues during transportation that need more attention are as follows:

- Contamination: Dirty vessels or entry of dust particles increases the initial bacterial load in milk and reduce its shelf life. Make sure that milk cans and other vessels are properly clean. Dirty containers are the important source of contamination which may be dangerous to health of the consumers. Keep the milk covered throughout its transportation. All the lids should be tightly placed to avoid spillage of milk. Protect milk from dust and other contaminants.
- Storage temperature: Although camel milk has comparatively higher shelf life, bacteria may grow faster and cause acidity when transported at higher temperature. All milk should be chilled after collected and try to maintain the temperature as cool as possible by using insulated containers or boxes, or by placing ice around the containers. Never expose milk to heat or direct sunlight. The time interval between milk collection and cooling is very crucial. Bacterial multiplication is very slow during the first 2 hours. After that bacteria will multiply very fast, with doubling time of 20-30 minutes. If unchilled milk is transported, one should make sure that it reaches its final destination within 2 hours from the time of milking.
- Exposure to light: Milk is very sensitive to light. If exposed to direct sunlight, milk fat and some vitamins get oxidized, and the milk develops bad and oxidized flavor.
- Excessive agitation: When milk is agitated the milk fat is destabilized and tends to oxidize easily. Always handle milk containers carefully. Cans should be filled full to avoid excessive agitation during transportation.

Handling at distribution/market level:

Customers are very particular about the premises from where they buy milk or other edible materials. One must sell milk in a clean, well lighted place with well dressed seller. After reaching the market, milk is often redistributed to smaller containers and delivered to separate customers. This is a new source of possible contamination. The following precautions are recommended:

- Wash milk containers very well, no traces of old or previously used milk should be present. Sterilize the containers with hot water and dry it by keeping it in inverted position. Don't use cloths for drying.
- Clean and sterilize all tools including funnels, measures, etc.
- Close the milk containers with a clean sterilized top/cover. Do not keep milk uncovered, as it will attract flies and other contaminants.
- Try to sell milk packed in suitable food grade packaging materials.

Cleaning and sanitation of dairy utensils

The milk secreted from animal's udder is generally clean and healthy. However, different level of contamination can occur during and after milking by the milker, milking utensils/ machines, cooling and storage. The unhygienic conditions of utensils may lead to severe contamination of milk and thereby quality deterioration. Dairy farmers/producers have responsibility of producing milk under clean and hygienic conditions, protecting from contamination by dirt and employing appropriate techniques to clean and disinfect the milking equipment, utensils and storage cans. This chapter will highlight the essential steps that must be taken during cleaning and sanitation of utensils and milking equipment at producers' or farm level to preserve milk.

Selection of Utensils for Milking/Storage:

Following general guidelines should be followed during selection of the milking vessels/utensils:

1. The pails/containers/cans made up of mild steel and HDPE/plastic material shall not be used for storage and transportation of milk.
2. The utensils/pails and the storage vessels should be of SS 304 construction and should have smooth surface with minimal joints and free from dents, cracks and crevices.
3. A suitable size lid should always be used to cover the utensils and the vessel.
4. Ensure that the milking utensils are uniform having small mouth so that dirt and flies do not gain easy access.
5. They should be exclusively used for milking and storage.
6. Separate vessel should be used for washing of udder and teats before milking.

Procedure for cleaning the milking utensils:

1. Immediately after emptying, the vessels should be rinsed with cold or lukewarm water to avoid drying and sticking of milk residues on the surfaces. If dried milk residues are present on the surface, soaking of the equipment may be required to soften the dirt and efficient cleaning.
2. After rinsing scrub utensils/pails thoroughly with a suitable brush, using hot water and efficient dairy cleaning/washing agents. About 10-15 g of the mixture will be required for cleaning utensil of 10-20 litre capacity.
3. Follow the washing up on scrubbing with hot water. The temperature water should be more than 50°C.
4. Then wash the utensil with enough cold water (tepid water in cold season) to remove traces of detergent.
5. Sanitization should be done by using acceptable sanitizing agent (iodophors/chlorine solutions (50-200ppm of active compound) to

disinfect the utensils. Hot water sterilization may also be practiced wherein the temperature should be as near the boiling point of the water but never below 85°C. The utensils should be immersed for 20 min. If it is not possible, boiling water should be poured over the milk-contact surfaces until they are too hot to touch.

6. Properly cleaned vessels should be placed in inverted position for the complete drainage of water.
7. Cleaned and dried utensils should be stored in an area protected from dust, dirt and other contaminants.

Choice of detergent/ Sanitizer

For general cleaning purpose: 1 Kg of detergent mixture should contain commercial washing soda- 850g, Tri-sodium phosphate- 100g, Sodium metasilicate- 50g and Teepol 10 ml.

Cleaning and Sanitation of Milking Machine

At present, the milking machines are not used frequently for milking camels in India. However, it is being used in large-scale commercial dairies abroad. Cleaning of milking machines requires special care as proper cleaning is very much necessary to maintain the quality of raw milk. The following methods can be adopted for better cleaning efficiency.

Manual Cleaning:

Bucket milking machines and clusters, and ancillary equipment's may be washed by hand. It may be done in three stages: a rinse with cold or tepid water (38-55°C), a warm detergent wash and a final rinse with clean water.

Procedure:

1. After milking, the outside of the milking unit should be cleaned by wiping and rinsing. Each unit should be rinsed by connecting the vacuum tube to a vacuum tap and drawing clean water through the teat cups. If the clusters are not cleaned immediately, they should be left immersed in water.
2. The warm detergent-disinfectant wash is the most important among the three.
3. Clusters should be washed first by full immersion for two minutes; teat cups, milk tubes and claws are scrubbed, and the cluster is re-assembled and transferred to the rinsing trough.
4. The final rinse in clean water, the addition of 50 ppm of hypochlorite significantly improves results. The clusters should be rinsed and hung up to drain.

In case of deposits on the milk-contact surfaces or high bacteriological counts, extra steps required are described below.

I. De-scaling with acid: Phosphoric acid is used to remove milk stone (milk and hard water residues). After cleaning, the metal components of the milking unit should be dismounted and soaked in the de-scaling solution, in accordance with the instructions of the manufacturer. All parts should be brushed with detergent-disinfectant solution and finally rinsed.

ii. Heat Treatment: If detergent-disinfectant solution is unavailable, heat treatment will be needed. The temperature of hot water should be more than 85°C, and rinsed through the clusters. After treatment, the equipment should be hung up to dry.

iii. Wet storage of clusters: Clusters are suspended in a rack in such a way that they can be filled with a suitable detergent-disinfectant solution between milking.

If milk has poor microbial quality, immediate attention to be given to following points:

- Old and worn rubber parts should be replaced, together with metal or plastic equipment that corroded or has open seams.
- Metal components should be de-scaled and rubber-ware be soaked in hot detergent disinfectant solution.
- Daily cleaning and disinfection methods should be checked and any fault should be corrected immediately.

In place cleaning

It is used when the milking equipments are connected with the pipelines and cooling tank. Two methods can be employed for in place cleaning: a. circulation and b. acidified boiling water cleaning method, the latter is less frequently used method.

a. Circulation cleaning

Circulation cleaning is a three-stage process consisting of a pre-rinse with water, a recirculated hot wash with detergent-disinfectant solutions and a final cold water rinse. The efficiency of circulation cleaning depends on the temperature of the water used for the detergent-disinfectant wash, the optimum initial temperature should be at least 85°C. Milking parlors with large-bore pipeline systems must have air-injectors to develop turbulence of the cleaning solution, which improves surface contact and disinfection efficiency.

In most of the cases, the protocol for circulation cleaning is usually provided by the milking machine manufacturer. However, some differences may exist between the various types of milking installations. The most commonly accepted procedure is as follows:

1. After milking, rinse the machine thoroughly with warm water, and brush

the clusters to remove external dirt. Attach the jetters to the cluster. Check the water temperature (85°C).

2. Drain the milk from the receiver and milk pump. Remove the filter sock (interior) and clean the filter as recommended by the manufacturer.
3. Connect the air pipeline directly to the water heater and set the three-way valve to the washing position so that the hot rinse water will be drawn into the machine. Set the releaser milk pump to run continuously and adjust the spreader on the receiver lid to the washing position.
4. Allow hot water to pass through the machine and discharge to waste until the temperature of the water leaving the machine exceeds 50°C. Add approved detergent-disinfectant solution to the measured volume of hot water, in accordance with the specifications of the manufacturer. Set the three-way valve to draw solution from the wash through the installation and continue circulation for 5-10 min. Discharge the detergent-disinfectant solution by deflecting the delivery pipeline.
5. Run clean cold water into the machine. Sodium hypochlorite may be added at a concentration of 50 ppm to avoid risk of contamination from supply lines.
6. Switch off the releaser and vacuum pumps; drain and prepare the machine for milking.

An acid rinse cycle may be performed to remove mineral deposits from water and milk. This may be a cold or warm rinse. The required frequency of acid rinse depends on the quality of the water used for cleaning. If a hypochlorite rinse is given for two minutes immediately before milking, it is not necessary to add hypochlorite to the final rinse.

a. Visual inspection: On the surface of utensils/equipments, brownish slimy appearance and mineral deposits caused by using hard water has rough porous texture and are visible when not cleaned properly. Discoloration may also occur due to corrosion and/or pitting of surfaces. Biofilms can be diagnosed by scrubbing a small area with concentrated acid and/or detergent solutions.
b. Rinse/Swab method: To maintain the quality of raw milk, it is recommended to verify the cleaning efficiency of utensils used for milking. Rinse method for cans/pails and Swab method shall be used for testing cleaning efficiency of milking equipment and its accessories. The standards for residual microorganisms in cans/pails fare as follows:

Standard plate count/litre of holding capacity:

Satisfactory	: Not more than 1000
Fairly Satisfactory	: Over 1000 up to 5000
Un satisfactory	: Over 5000

Sample collection/ Milk sampling

Proper sampling of an aliquot is important for accurate analysis. The sample should be true representative of the substances or the batch of substances from which it is obtained. It should be dispatched immediately to the laboratory packed in icebox to prevent bacterial growth and multiplication and other inherent chemical changes in milk. The sample bottle should be marked properly with the following general information:

- Date of sampling,
- Time of sampling,
- Name and address of owner, and
- Species of animal,
- Place of sampling,
- Name and quantity of preservatives added, if any. In case of preservative added is poisonous or harmful for human being, it should be clearly marked with RED INK as 'POISON'.

Materials required:

- Plunger,
- Dipper, and
- Sample bottle.

For bacterial analysis of milk sample, the plunger and dipper should be sterilized by:

- Hot water immersion at 71°C for atleast 2 min, or
- Dipping in chlorinated water for atleast 2 min. The chlorine content of water should not be less than 100ppm, or
- Hot air oven sterilization at 160°C for 90 min.

The glass sample bottle used for collecting milk samples for bacteriological examination should be sterilized in hot air oven at 160^0C for atleast 1h and the cork should be sterilized by boiling in water for atleast 10min before use. Plastic sample bottle should be sterilized by rinsing with a small amount of absolute alcohol. However, for other routine laboratory test, these apparatus need not necessarily be sterilized as described above. It is sufficient if these are clean and dry.

Procedure for sampling of milk:

From individual camel/udder:

1. Clean the flank and the udder with body brush and clean wet cloth

respectively.

2. Wipe the udder with hypochloride solution (500ppm).
3. Mope dry the udder with a clean and dry cloth.
4. Discard fore-milk except for bacteriological examination.
5. Milk the cow completely and mix thoroughly with a suitable plunger.
6. Obtain proportionate quantity of milk with a dipper in a sample bottle.
7. Mark for identification.
8. Transfer the sample in the laboratory in ice-box immediately.

From one container:

1. Mix the sample effectively with a plunger or by pouring the contents of one container to another several times taking care to avoid incorporation of air.
2. Take the proportionate quantity of milk with a dipper in a sample bottle.
3. Mark for identification.
4. Dispatch to the laboratory in ice-box immediately.

From more than one container:

1. Mix the milk of all cans properly with a plunger.
2. Withdraw equal amount of milk from all the containers with a suitable dipper or a sample tube. In case all cans are not of the same capacity and/or not completely filled, proportionate amount of sample should be obtained from each can. For example, if can 'A' contains 10 liters of milk and can 'B' 20 liters, then if we withdraw 100ml of milk from can 'A', we should obtain 200ml of milk can 'B'.
3. Mark for identification.
4. Dispatch to the laboratory in ice-box immediately.

From bottled/polypacked milk:

1. Collect 2 to 3 bottles/sachets at random from bottling plant or from the distribution center.
2. Mark for identification.
3. Dispatch to the laboratory in ice-box immediately.

From weigh tanks/storage tanks:

1. Mix the milk thoroughly with a plunger. In case of cold milk, agitate for atleast 3 to 5 min before sampling.
2. Withdraw a small amount of the sample into a sample bottle with a suitable dipper.
3. Mark for identification.
4. Dispatch to the laboratory in ice-box immediately.

From mixed samples:

1. Mix together proportionate amount of different lots of a product with the help of a plunger.

2. Withdraw a small amount of aliquot into a sample bottle with a suitable dipper.
3. Mark for identification.
4. Dispatch to the laboratory in ice-box immediately.

From composite samples:

1. Mix thoroughly the composite sample of an individual cow or of a herd from each milking with a plunger.
2. Transfer proportionate amount of the aliquot into a rubber stoppered sample bottle containing little amount of formalin (1ml of formalin for every 0.94633 liters of the aliquot).
3. Withdraw a small amount of the sample into a sample bottle with a suitable dipper.
4. Mark for identification.
5. Dispatch to the laboratory in ice-box immediately. Exposure to sunlight should be avoided.

Rapid platform tests

Milk produced under unsanitary conditions and exposed to warm atmospheric conditions for long period have poor keeping quality and also evident various defects due to excessive bacterial growth. Such milk supplies are unsuitable for processing into various dairy products. Hence, sorting out of such milk is necessary at the milk collection center or dairies. A number of tests generally performed on milk receiving platform are recommended. These tests are based on rapid assessment of changes brought about in milk due to bacterial growth. Some of the rapid platform tests are:

1. Organoleptic tests,
2. Clot-on-boiling (COB) test,
3. Alcohol test,
4. Resazurin test.

1. Organoleptic tests: Subjective evaluation of milk also gives valuable information about its quality. Human sense of smell, teste and vision are involved in these tests and hence, known as organoleptic tests.

Smell: Consumers prefer milk with pleasant sweet flavor and uniform palatability. Normal camel milk has slightly salty taste, however, milk may occasionally have off-flavor which may be attributed to some of the feedstuff, e.g., silage etc., being fed to the animal before milking. Normal smelling milk may also absorb off-flavor from the surroundings due to excessive exposure to light, contact with certain metallic equipments or due to inherent chemical changes taking place during handling. However, the most important factor for production of off flavor in milk is growth and multiplication of bacteria. This test furnishes an excellent indication of the organoleptic quality of milk that can be ascertained very quickly.

Appearance: Fresh, normal camel milk is complete white in colour. Presence of any other colour, floating hair, dust particles, oil specks, churned particles etc. are objectionable.

Taste: The taste of good milk is regulated by two components: (a) the balance between the milk sugar's sweet taste and the ash's salty taste and (b) the balance between fat and protein. The former component results in a slightly salty taste and the latter gives taste of richness. The taste of normal camel milk is slightly salty.

Procedure for performing organoleptic tests: Soon after removing the lid of the container/can, organoleptic tests are performed in the following way:

- Smell the milk,
- Observe the appearance,
- Taste the milk (if it is known that milking camels are free from diseases transmissible to man).

- Check the lid after removal and the container as soon as it is emptied and record your observation.

2. Clot-on-boiling (COB) test:

When milk sours a clot is formed, the size of clot varies with the age of the milk sample and state to which the souring has reached. Normal fresh milk does not coagulate when boiled. Camel milk forms small particles when boiled for longer duration, which should not be taken as positive for COB test. It should be cross-checked with other tests before arriving at final conclusion. If the milk is heavily contaminated with lactic acid bacteria it curdles. These microorganisms produce lactic acid from lactose. When milk reaches high-developed acidity (0.17% lactic acid), it curdles on boiling. Instability on boiling may also be due to (a) very high protein content as in the case of colostrum (20.68% protein) and (b) increased salt concentration as in the case of mastitic milk. This is fairly good test and indicates about the quality of the milk promptly. The purpose of this test is to ascertain the suitability of milk for heat processing and for marketing as fluid milk.

Materials required: Test tube marked at 5ml, Test tube holder, Pipette (optional) and steaming hot water bath.

Procedure:

1. Transfer 5ml of well-mixed sample to the test tube with the help of a pipette,
2. By holding the test tube with the help of a test tube holder heat the sample in steaming water bath for 5min.
3. Remove the test tube from water bath and rotate it gently holding the tube in almost horizontal position and observe for any precipitate on the side of the test tube.

Interpretation: Presences of any precipitated particles indicate a positive result.

3. Alcohol test: The principle of this test is similar to that of clot-on-boiling test excepting that in this test alcohol is used instead of heat to obtain clotting.

Materials required: Test tube (10ml) with stand and Pipette (5ml).

Reagent required: Ethyl alcohol (75% v/v or 68% w/v).

Procedure:

1. Transfer 5ml of mixed milk sample into the test tube,
2. Add equal amount of 75% ethyl alcohol to it,
3. Mix the content of the test tube by inverting the tube for several times,
4. If no coagulation is observed, keep the sample undisturbed in the test tube stand for 10min.
5. Observe for any coagulation after the 10min of holding.

Interpretation: Appearance of small, medium or large flakes of curd on side of the test tube indicates positive result. Large flakes generally indicate instability to heat. Absence of any flakes indicates negative results.

4. Resazurine test: It is a bacteriological quality control test based either on (a)

the colour produced after a stated period of incubation, or (b) the time required to reduce the dye to a given end point. The most commonly used methods for this test are (1) 'one-hour-test', and (2) 'triple-reading-test'.

Materials required: Test tube (15 ml, sterilized), Test tube rack, Pipette-graduated (1ml and 10ml), Rubber bung and Bacteriological incubator.

Reagents required: Resazurine solution and hot distilled water.

Preparation of resazurine solution: Dissolve one resazurine tablet (dye content per tablet is approximately 1mg) in 200ml of hot distilled water. Working solution must be prepared immediately before use.

Procedure:

1. Transfer 1ml of the prepared working dye solution (resazurine solution) into a sterile test tube,
2. Add 10ml of well mixed milk sample into the test tube and fix the stopper properly,
3. Incubate the sample mixed with dye in a bacteriological incubator at 36^0C,
4. Tubes are examined once at the end of one hour incubation in the 'one hour test' and for three times each at the end of 1, 2 and 3 hours in the 'triple reading test'.

Interpretation: The result can be interpreted based on the colour changes as shown below. However, the result may be supported by microscopic examination.

Grading of milk on the basis of resazurine test:

Colour of the sample	**Quality of milk**
Blue (no colour change)	Excellent
Blue to deep mauve	Good
Deep mauve to deep pink	Fair
Deep pink to whitish pink	Poor
White	Bad

Fig. 9 Lactoscan

Primary processing and preservation

The primary processing of milk refers to processes that make milk ready for human consumption. As milk may harbor dust particles, certain bacteria or other contaminating agents that may affects the keeping quality of milk and the health of the consumer. Therefore, milk produced at farmer's door should go through certain processes before presented or sold to consumers. These primary process include filtration, clarification/bactofugation, chilling, cream separation, homogenization, heat preservation (boiling, pasteurization, etc.) etc. However, some of these processes may not be essentially required for camel milk. For example, camel milk contains less amount of fat as compared to milk of other dairy animals, cream separation is not required unless specifically needed for skimmed milk production. Another process called homogenization may also be excluded while designing the steps of primary processing, because the size of fat globules are so small that it does not form a cream layer when kept undisturbed. Therefore, in this section only important processes essentially required for camel milk processing will be discussed in detail.

Functions of primary processing of milk:

- Prepare raw milk ready for human consumption.
- Extends the shelf life of the raw milk by placing it in suitable conditions so that it is transported safely to a food manufacturer or consumer marketplace.
- Protect fluid milk from contamination.
- Prepare raw material ready for delivery to dairy products manufacturers for conversion into other value-added products.
- Quality assurance of the farm produce.

Filtration: It is a process for removal of foreign particles and, dirt/dust from the milk. During handling in farm and its transportation, certain visible particles and dirt may gain access into the milk which can be removed by either filtration or centrifugal clarification. Filtration/clarification equipment has been designed for both cold and warm milk. Since fluidity of warm milk is more, separation process works more efficiently. Filtration can be achieved in following steps:

Pre-heating: The milk is pre-heated to about 35-40°C using plate or tubular heater for efficient filtration/clarification. Pre-heating becomes essential if the coming milk is cold.

Straining: The practice of straining milk helps in removal of the large particles such as straw, hair, insects, grass, dirt, flies, etc., so that the visible sediment in milk is reduced. Straining is performed using pieces of cloth, cotton, wire gauge or specially prepared strainers/strainer pads.

Filtration: Filtration is carried out to remove visible sediment (foreign matter) from the milk. This may be done either by filtration or centrifugal clarification.

There are two types of filters or clarifiers viz., those that operate with cold milk and those that operate with warm milk. The advantages of filtration are that preheating is not essential and there is less likelihood of soluble dirt going into the solution. However, the major disadvantage is that flow of milk is slow.

Important features of a filter:

- A filter cloth or pad of the desired pore size is used that can retain the smallest particle.
- A frame or support to compress and hold the margins of cloth or pad, so that milk can pass through pore.
- A perforated metal or other support for the cloth or pad that will not tear or break under the pressure of milk.
- An enclosure to confine both the filtered and unfiltered milk in a closed system fitted suitably with inlet and outlet connections for sanitary piping.
- A continuous operation is essential to handle large volume of milk; 2 or more filters may be used without interruption.
- For cold filtration, an in-line filter may be installed in the milk receiving line between the raw milk dump tank, unloading pump and chiller or raw milk storage tank. Warm milk filters may be installed in the pasteurization circuit.

In order to achieve the desired filtration effect, the filter material should have pore size 25 - 100 μ. The smaller the pores, the greater are the separation effect and filtration time. Changing of filter after every 6 h of operation is recommended.

The filter assembly consists of stainless steel body wherein a filter with a small pore nylon cloth is placed and closed with a tight fitting lid. Milk passes from the top to bottom. After 3 - 4 h of operation, the filter bag should be cleaned. For a continuous process, a double filter should be installed. This would enable cleaning of one filter while the other is being used. The flow rate of milk when using such type of filter can be up to 15000 L/h.

Pasteurization of Milk:

According to International Dairy Federation (IDF), pasteurization can be defined as 'a process applied to a product with the object of minimizing possible health hazards arising from pathogenic microorganisms associated with milk by heat treatment, which is consistent with minimal chemical, physical and sensory changes in the product'.

In general, the term pasteurization as applied to market milk refers to the process of heating every particle of milk to at least 63°C for 30 min or 72°C for 15 seconds or to any temperature-time combination which is equally efficient, in a properly operated equipment. After pasteurization, the milk is immediately cooled to 5°C or below.

Traditional camel milk consumers commonly believe that camel milk should be consumed raw to get all the benefits from it. However, scientifically it is recommended not to consume raw milk of any species unless the lactating animal is free from any disease conditions. To overcome this myth, due consideration to following scientific reports and evidences is warranted:

- Camel milk is more heat resistant than those of cow milk (Wernery et al. 2003).
- Only 5-8% reduction in Vit. C & Insulin content was observed when heated at 63°C for 30 min. (Wernery 2007).
- The antimicrobial factors in camel milk are also more heat stable than those in cow milk. (El-Agamy, E.I., 2000).
- Whey proteins in camel milk are more heat resistant than cow milk, as the degree of denaturation when heated at 80°C for 5 minute varied between 32-35% and heating at 72°C for 5 minute revealed no losses in camel milk, whereas in cow milk 70-75% of whey proteins are denatured at 80°C for 5 min. (Wernery et al. 2003).

Therefore, camel milk should also be pasteurized before consumption by either method described below.

Importance of Pasteurization:

- It renders milk safe for human consumption by destroying all the pathogenic microorganisms.
- It improves the keeping quality of milk by killing almost all spoilage organisms (88-99%).

Methods of Pasteurization:

Low-temperature long-time (LTLT)/Batch pasteurization:

The milk is heated to a minimum of 62.7°C and held at this temperature for minimum 30 minutes. Thereafter, it is cooled as rapidly as possible to 5°C. This operation is performed in a closed vessel having jacket for circulating heating and cooling medium. To heat the milk, hot water or low-pressure steam is circulated through the jacket and milk is continuously agitated for rapid and uniform heating. The heating process could be manually or automatically controlled. A cooling medium such as brine or chilled water is circulated in the jacket for chilling the milk.

High-Temperature Short-Time (HTST) Pasteurization:

This method is invariably used for pasteurizing milk in large volumes. The HTST pasteurizer gives a continuous flow of milk which is heated to 72°C for 15 sec and then promptly cooled to 5°C or below. It has several advantages over LTLT method.

Advantages:

- Capacity to heat treat milk quickly and adequately, while maintaining rigid quality control over both the raw and finished product

- Less floor space required
- Lower initial cost
- Milk packaging can start as soon as milk is pasteurized
- Easily cleaned and sanitized (system adapts itself to CIP)
- Lower operating cost (due to regeneration system)
- Reduced milk losses
- Development of thermophiles is not a problem
- Automatic precision controls ensure proper pasteurization.

This method involves complex system consisting of float controlled balance tank, heat generation system, cooling system, plate heat exchanger, holding tube, etc. The plant operation and maintenance becomes easy when automatic controlling of all operations including CIP cleaning is practiced.

After pasteurization, milk should be packaged using suitable packaging material depending upon the requirement. The packaging containers may be polythene pouches, glass bottles, plastic bottles or for bulk supplies big cans/containers made up of metal/plastic.

Fig. 10 HTST Milk Pasteurizer

Marketing of camel milk

Milk is the main output of the dairy enterprise. Therefore, importance of milk marketing stands foremost among all the dairy products. Furthermore, the perishable nature of raw milk makes the marketing more crucial for the small-scale milk producers. In India, like other developing countries, marketing of milk and milk products are controlled by both organized and unorganized sectors. However, for camel milk marketing, there are few camel breeder association, NGOs and small entrepreneurs, who have started collection, processing and marketing of camel milk recently. The National Research Centre on Camel, Bikaner is also selling camel milk and milk products through its milk parlour. In India, AMUL has also stared collection, processing and marketing of camel milk in Gujarat.

Packaging and labelling: Attractive packaging of milk and milk products allure more consumers to buy the products. Labeling also plays an important role in marketing milk and other food products. Information related to nutritional facts, manufacturing and expiry dates, uses instruction, etc. help educating consumers about the products and builds confidence in buying them..

Marketing in the local market: Camel milk marketing in India was not organized until recent past. Therefore, most of the milk produced was consumed locally either by the producer itself or by nearby families or tea stall owners.. While marketing milk in the local market which includes collection, filtration and distribution of milk to door step or selling from a point, it becomes very important to keep the milk in cold condition in closed containers to avoid deteriorative changes. Further, prolonged transporation of raw camel milk is not advisable when there is lack of cooling facilities and the containers are not completely filled. The incomplete filling of containers may lead to churning of milk fat during transportation due to continuous agitation. For convenience in marketing, the filtered milk can be packed in required amount using suitable packaging material. It will not only facilitate easy distribution, but also prevent contamination during distribution.

Marketing through dairy booth in multiple cities: Milk must be pasteurized to extend the shelf life if it is to be distributed in multiple cities. The pasturized milk should be transported to destination in cooled condition. The packing should also be labelled with adequate information including date of manufacture/expiry. Freezing the milk packets will further extend safe storage and transportation time.

Fig. 11 Packed Camel milk

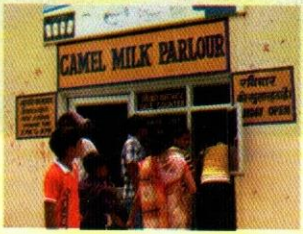

Fig. 12 Milk Parlour at NRCC

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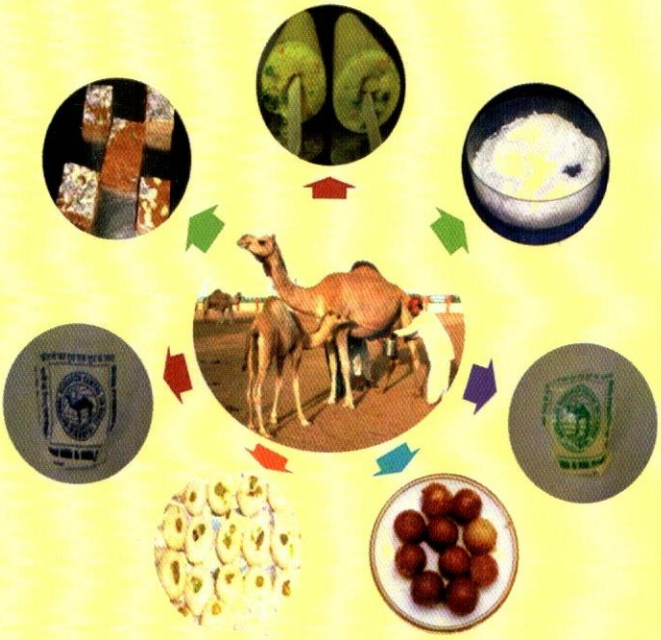

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