



Hygienic milk collection and testing

A training guide for milk collection centre operators in Eastern Africa



TDB

Tanzania Dairy Board



A Programme of the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA)



FEBRUARY 2006

MODULE 2

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operators in Eastern Africa



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Printing: Regal Press Kenya Limited, Nairobi

ISBN: 92-9146-189-x

Correct citation: Lore, T.A., Kurwijila, L.R. and Omoro, A. (eds). 2006. *Hygienic milk collection and testing: a training guide for milk collection centre operators in Eastern Africa*. ILRI (International Livestock Research Institute), Nairobi, Kenya.



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Acknowledgements

The Dairy Development Authority (Uganda), the Kenya Dairy Board, the Rwanda Animal Resources Development Authority and the Tanzania Dairy Board thank the following individuals and institutions whose untiring efforts led to the successful compilation of this training guide:

- National resource persons nominated by the aforesaid institutions for collecting information that helped in drawing up the harmonised generic training guide and curriculum:
 - Mr Isha Muzira (Uganda)
 - Dr Philip K Cherono (Kenya)
 - Dr Michel Ngarambe (Rwanda)
 - Mr Obed Ndankuu (Tanzania)
- The Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) through its Programme for Agricultural Policy Analysis (ECAPAPA) for funding and providing leadership to the two-phase project on *Rationalisation and harmonisation of policies, standards and regulations in the dairy industry in Eastern Africa* from 2002 to 2005.
- The International Livestock Research Institute (ILRI) for collaboration through its research theme on market-oriented smallholder dairy.
- Prof Lusato Kurwijila of Sokoine University of Agriculture, Morogoro, Tanzania for sharing his technical expertise and knowledge of the dairy industry in Africa that was instrumental in developing the harmonised training guide and curriculum.
- Dr Amos Omoro (ILRI) for coordinating the work of the national resource persons and facilitating dialogue and exchange of experiences in improving the quality of milk sold in the informal sector.



- Ms Tezira Lore (ILRI) for editing, proofreading and designing the layout of the guide.
- Ms Lilian Ohayo for providing illustrations.
- US Agency for International Development (USAID), Regional Economic Development Services Office for East and Southern Africa, for financial support.

It is our desire and hope that the use of this guide in training programmes will contribute to the improvement of milk quality along the marketing chain and provide income generation opportunities for those involved. We look forward to continued collaboration with the above institutions as we strive to strengthen the dairy industry and cross-border trade in the region.



Foreword

As a milk collection centre operator, you know very well how the quality of the raw milk you receive from different farmers often varies widely. Thus, it is important to have adequate knowledge and skills to enable you to distinguish between poor and good quality milk. You also need to know how to handle and store good quality milk so that its quality is maintained until the time it is delivered to the cooling centre, milk processing factory or point of sale. This will help to avoid unnecessary losses of milk due to spoilage.

With this in mind, this training guide was developed through collaboration between dairy regulatory authorities in Kenya, Rwanda, Tanzania and Uganda; the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) through its Programme for Agricultural Policy Analysis (ECAPAPA) and the International Livestock Research Institute (ILRI).

The aim of this document is to help you acquire basic knowledge and skills in the following areas:

- Hygienic milk production
- Hygienic milk handling
- Milk quality control and testing
- Milk quality grading and payment systems

The guide is designed to be used during on-site training (2-3 hours per day) or for outreach training (1-2 days) by a business development service (BDS) provider at a suitable location near your milk collection centre. The module also applies to milk collection centres that have cooling facilities. After the training, you will undergo a theory and practical test to evaluate your level of competence in hygienic milk handling. Upon passing the test, you will be awarded a **certificate in basic milk quality control and testing**. You will need to obtain this



certificate before you can be licensed by your national dairy board or authority to operate a milk collection centre.

There are similar training modules for farm level workers, transporters, small-scale traders and milk processors that cover the minimum competencies for hygienic milk handling and processing. A module on basic marketing and dairy business management is not mandatory for licensing of small-scale dairy operatives but is optional for those who desire basic training in this area.

As dairy regulators in Eastern Africa, we recommend this guide for training and certification of milk collection centre operators.

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HYGIENIC MILK PRODUCTION

Milk from the udder of a healthy cow contains very few bacteria. Poor hygiene introduces additional bacteria that cause the milk to get spoilt very quickly. To ensure that raw milk remains fresh for a longer time, good hygiene must be observed during milking and when handling the milk afterwards.

Important factors that influence milk quality

Feeding

A well-fed and watered animal will produce high quantities of milk of good composition. If cows are fed a diet that is low in forages and high in starch, the butterfat content may fall below 2.5%. Thus, a good balance of forage and concentrates is important. Cows may be given feed supplements but it is important that the proper proportions be observed. Cows should not be fed with silage during milking or shortly before milking, as this will give rise to off-flavours in the milk. It is recommended that silage feed be provided two hours before milking.



Keep your cows well-fed and healthy

Health of the cow

An unhealthy cow will feed less and produce less milk of poor quality. Cows should always be kept healthy and clean because sick animals can transmit diseases like tuberculosis and brucellosis to milk consumers. If a cow is suspected to be sick, a qualified veterinary practitioner should be contacted immediately. Milk from a cow that is being treated with antibiotics should not be sold or consumed until after the specified withdrawal period.



Animal and udder health

Zoonoses

Zoonotic diseases like tuberculosis and brucellosis can be spread to humans through milk. Cows suffering from such diseases should be referred to a qualified veterinary practitioner who will decide on the fate of the animal. Farmers are encouraged to vaccinate their animals against brucellosis. Animals should also be checked periodically for all types of contagious diseases and treated promptly in case of infections.

Mastitis

Mastitis is an inflammation of the mammary glands in the udder caused by infection with disease-causing bacteria. These bacteria can also end up in the milk and result in illness if the milk is consumed. For this reason, milk from cows suffering from mastitis should not be sold or drunk. You can control mastitis by observing general hygiene and proper milking procedures. Hair at the udder should be kept short by trimming. Cows suffering from mastitis should be treated by a qualified veterinary practitioner. Milk from animals that are undergoing antibiotic treatment should not be consumed or sold until the withdrawal period has elapsed because antibiotic residues may cause allergies and drug resistance in consumers.

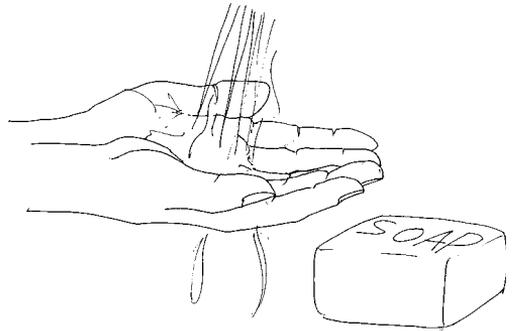
Hygienic milking

Good hygiene and quality control needs to be observed at all stages of milk production, handling and sale. Thus, hygienic practice must begin at the farm level. Good hygiene will ensure that the milk you collect is clean and has low levels of spoilage bacteria. Below is some advice you can give to the farmers who bring milk to your collection centre, in order to ensure good quality:

- Maintain clean and healthy cows.
- Keep a clean milking environment, free of dust and mud.
- Do not milk cows if you are suffering from communicable diseases like diarrhoea or typhoid, but seek medical treatment and resume milking only when you have fully recovered.

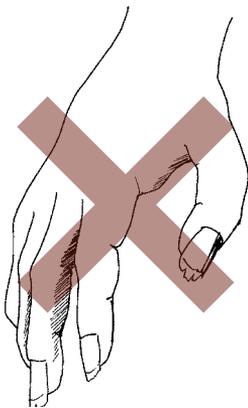


- Do not mix colostrum (the milk produced for the first seven days after calving) with normal milk.
- Wash your hands with soap and clean water before milking.
- Wash the udder with a clean cloth and warm water.
- Dry the udder with a clean dry cloth.
- Make the first draw into a strip cup to check for mastitis and throw away from the milking area even if the milk appears clean.
- Use clean containers for milking.
- Cows with mastitis should be milked last and their milk discarded.
- Milk from cows under antibiotic treatment should not be sold or consumed until 3 days after last treatment or as advised by the veterinary practitioner.
- After every milking, dip the teats into an “antiseptic dip”.
- During milking, the milker should **not**: (a) have long nails, (b) sneeze, spit or cough, (c) smoke.



Wash hands with soap and clean water

During milking, do NOT...



...have long nails



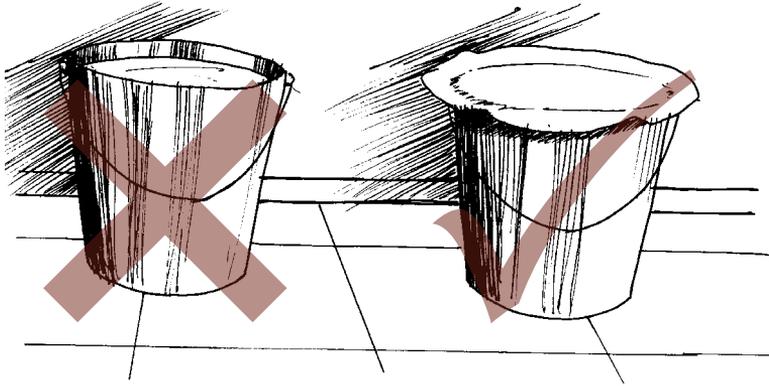
...smoke



...sneeze or cough



- Release the cow from the milking area as soon as milking is finished.
- After milking, sieve the milk through a strainer or muslin cloth to remove solid particles that may have fallen in during milking.
- Cover the milk to avoid contamination.
- Move the milk to a clean and cool area.



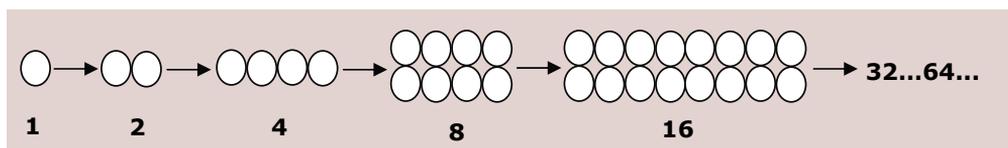
Cover the milk to avoid contamination



HYGIENIC MILK HANDLING

What causes milk spoilage?

It is important for you to know some of the things that can cause milk spoilage so that you can avoid unnecessary losses. Milk is very rich in nutrients. Because of this, the bacteria that cause spoilage can grow very quickly in milk. Bacteria cells grow by dividing into two. If milk is stored at high temperatures for a long time then the bacteria will grow and divide very fast and soon the milk will have a very high number of bacteria and thus get spoilt quickly. Also, if the milk had a high number of bacteria to begin with then it will get spoilt in a very short time.



Bacteria cells grow by dividing into two

Poor hygiene during handling of milk and undesirable practices like addition of water and other substances can introduce the bacteria that cause milk to go bad. Here are some guidelines to follow in order to avoid milk spoilage:

- Always handle milk in clean metal containers.
- When transferring milk between containers, pour the milk instead of scooping. Scooping may introduce spoilage bacteria.
- Do not store milk at high temperatures.
- Avoid keeping milk for a long time before it is delivered to the collection point.
- Do not handle milk if you are sick. Seek medical treatment and resume your work only when the doctor says you are fit to do so.





Scooping may introduce spoilage bacteria

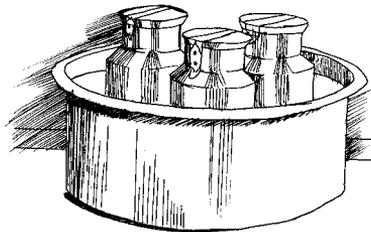


Transfer milk between containers by pouring

How to store milk to reduce spoilage

Because milk spoils easily if it is left at high temperatures for long periods, you need to keep it in a cool place soon after milking. The low temperatures reduce the rate of growth of the spoilage bacteria. If you do not have a refrigerator or cooler, you can store milk in a cold-water bath or wrap the milk can with a wet sack, but ensure that the milk container is well covered to prevent dirt from entering the milk.

You can store milk safely by keeping it covered...



...in a cold water bath



...in a cool cupboard or wet charcoal cooler



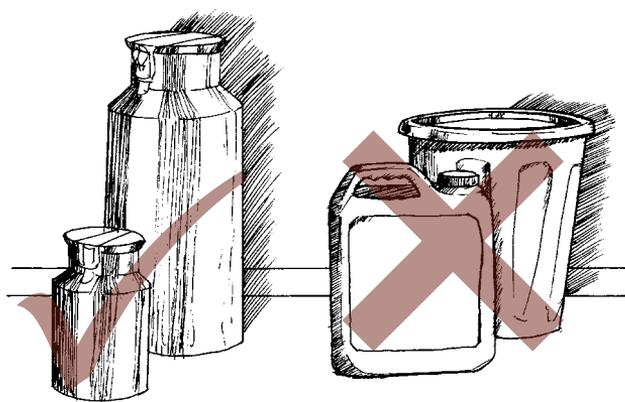
...in a milk can wrapped in a wet sack



Equipment for milk handling and storage

Always use certified foodgrade containers, e.g. aluminium, stainless steel or foodgrade plastic jerry cans designed for single use only. Metal containers are preferable because these are easy to clean and sterilize.

Do not store milk in plastic jerry cans that previously contained paint, herbicides and other chemicals because traces of these substances can taint your milk.



Store milk in metal containers, NOT plastic jerry cans

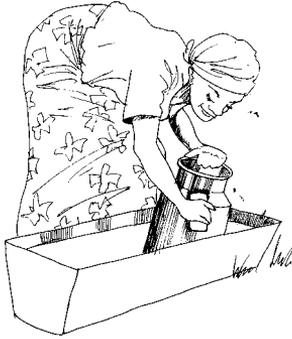
Safe use of cleaning and sanitation detergents

There are various types of cleaning and sanitation agents that have been specially designed to clean and disinfect milk-handling equipment. You may also use food-grade liquid soap, which is a good cleaning agent that also destroys bacteria. Always rinse your equipment properly after cleaning to prevent detergent residues from contaminating the milk.

Cleaning agents should be stored properly and handled with care because some of them may be corrosive to the skin. Always follow the manufacturer's instructions for proper use of detergents.



Procedure for cleaning of milk containers



Scrub container with warm water and soap

Before re-using the milk container:

- Pre-rinse the container soon after use.
- Thoroughly scrub the container with warm water and detergent or soap (using a stiff bristled hand brush or scouring pad).
- Rinse the container in clean running water.

- Dip-rinse the container in boiling water for at least one minute to kill germs. You may also rinse the container by pouring hot water into it.
- Air-dry the container in inverted position on a clean rack in the open.

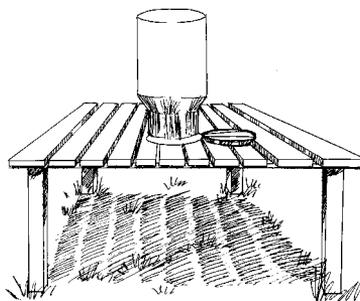


Dip-rinse the container in boiling water for at least one minute to kill germs

OR



Rinse by pouring hot water into container



Air-dry the container in inverted position on a clean rack



BASIC MILK QUALITY TESTS

There are four simple tests for milk quality that you can carry out at the milk collection point:

- Sight-and-smell (organoleptic) test
- Clot-on-boiling test
- Alcohol test
- Lactometer test

These tests will help you to ensure that only milk of acceptable quality is received. Usually during testing, only a small amount (sample) of milk from each container is assessed. If the sample of milk doesn't pass the test, the milk from that container should not be accepted. Thus, it is important to advise the farmer to always carry out milking and handling in accordance with good hygienic practice.

Organoleptic test

This test is performed first and involves using the senses to assess the milk with regard to its smell, appearance and colour. This test is quick and cheap to carry out, allowing for segregation of poor quality milk. No equipment is required, but you should have a good sense of sight and smell. Milk that cannot be adequately judged in this way is subjected to tests that are more objective.

Procedure

- Open a can of milk.
- Immediately smell the milk and establish the nature and intensity of smell, if any. Do not accept the milk if it smells slightly sour or has foreign odours like paint or paraffin.



- Observe the colour of milk. Deviation from the normal yellowish-white colour indicates damage to the udder (reddish—blood, or yellow—pus).
- Check for any foreign bodies or physical dirt, which may indicate that the milking and handling were not done hygienically.
- Touch the milk container to feel whether it is warm or cold. This indicates how long milk has taken since milking (if not chilled thereafter) and will influence the lactometer test for adulteration (see below).

Judgement

Abnormal appearance and smell that may cause milk to be rejected could be due to:

- Type of feed or atmospheric taint
- Cows in late lactation
- Bacterial taints
- Chemical taints or discolouring
- Advanced acidification or souring

Marked separation of fat may be caused by:

- Milk previously chilled and subjected to excessive shaking during transportation
- Adulteration with other solids (may also show as sediments or particles)
- Boiling, if milk fat is hardened

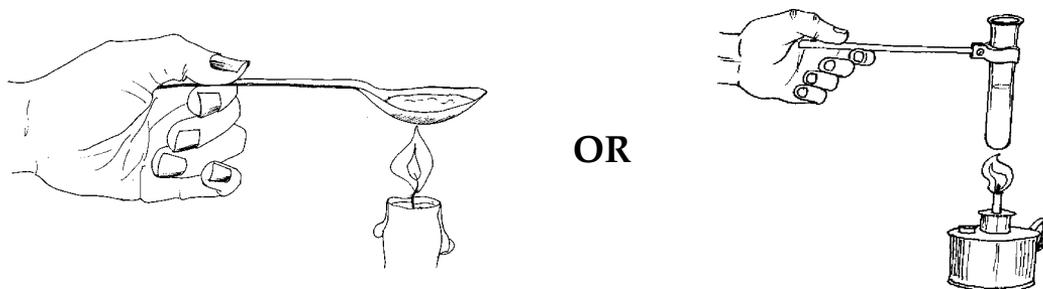
Clot-on-boiling test

This test is quick and simple. It allows for detection of milk that has been kept for too long without cooling and has developed high acidity, or colostrum milk that has a very high percentage of protein. Such milk does not withstand heat treatment hence this test could be positive at a much lower acidity.



Procedure and judgement

- Boil a small amount of milk for a few seconds in a spoon or other suitable container.
- Observe immediately for clotting.
- The milk will be rejected if there is visible clotting, coagulation or precipitation.



Carrying out the clot-on-boiling test

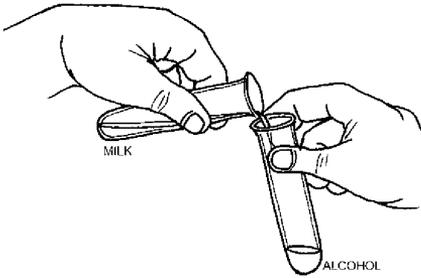
Alcohol test

The test is quick and simple. The specific type of alcohol used is known as “ethanol”. This test is more sensitive to lower levels of acidity and can therefore detect bad milk that may have passed the previous two tests. It also detects milk that has kept for long without cooling, colostrum or milk from a cow with mastitis. Because this test is quite sensitive, milk that passes this test can keep for some hours (at least two hours) before it goes bad.

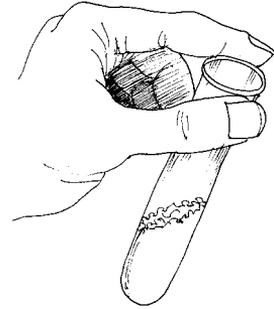
Procedure and judgement

- Use a syringe to draw equal amounts of milk and 70% alcohol solution into a small tube or glass cup (such as those used to administer medicine to children).
- Mix 2 ml milk with 2 ml 70% alcohol and observe for clotting or coagulation.
- If the tested milk sample coagulates, clots or precipitates, the milk will be rejected.



The alcohol test

Mix 2 ml of milk with 2 ml of 70% alcohol



If the milk coagulates, it fails the test

Lactometer test

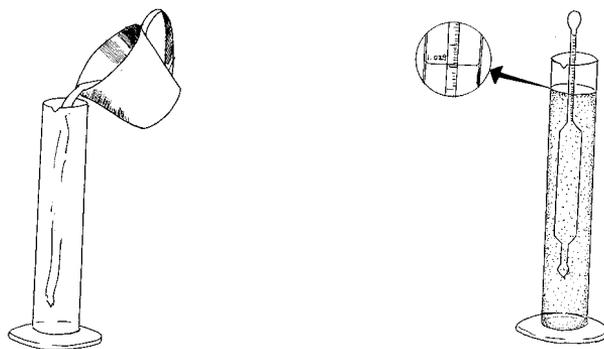
Some unscrupulous milk suppliers adulterate milk with added water to increase the volume or added solids to make it look thicker. Addition of anything to milk can introduce bacteria that will make it spoil quickly. Adulteration of milk is also illegal. The lactometer test is used to determine if the milk has been adulterated with added water or solids.

This test is based on the fact that milk has a heavier weight or density (1.026–1.032 g/ml) compared to water (1.000 g/ml). When milk is adulterated with water or other solids are added, the density either decreases (if water is added) or increases (if solids are added). If milk fat (cream) is added to milk, the density decreases. The equipment used to measure milk density is called a lactometer. Most lactometers are usually marked from “0” (representing density of 1.000 g/ml) to “40” (representing density of 1.040 g/ml).

Procedure

- Leave the milk to cool at room temperature for at least 30 minutes and ensure its temperature is about 20°C.
- Stir the milk sample and pour it gently into a 200 ml measuring cylinder or any container deeper than the length of the lactometer.
- Let the lactometer sink slowly into the milk.
- Take the lactometer reading just above the surface of the milk.





Equipment used for determining the milk density

If the temperature of the milk is different from the lactometer calibration temperature (20°C), then use this correction factor:

- For each °C above the calibration temperature, add 0.2 lactometer “degrees” (°L) to the observed lactometer reading.
- For each °C below calibration temperature, subtract 0.2 lactometer “degrees” (°L) from the observed lactometer reading.
- Note: These calculations are done on the lactometer readings (e.g. 29 instead of the true density of 1.029 g/ml).

Examples of how to calculate the true lactometer readings when the milk temperature differs from the calibration temperature of 20°C

Milk temperature °C	Observed lactometer reading °L	Correction °L	True lactometer reading °L	True density g/ml
17	30.6	- 0.6	30.0	1.030
20	30.0	nil	30.0	1.030
23	29.4	+ 0.6	30.0	1.030

Judgement

If the milk is normal, its lactometer reading will be between 26 and 32. If the lactometer reading is below 26 or above 32, the milk will be rejected because it means that it has been adulterated with added water or solids.



MILK QUALITY GRADING AND PAYMENT SYSTEMS

Certain tests can be carried out to grade raw milk and hence determine the payment to be made to the farmer. These tests are done at cooling centres and processing plants before they receive the milk. Here we discuss how to carry out two of these tests: the resazurin and butterfat tests.

Resazurin test

The resazurin test is used to determine the quality of raw milk in terms of the amount of bacteria it has. Milk with high amounts of bacteria will not keep for long. Resazurin is a dye indicator that is blue in the presence of oxygen and white when oxygen levels are reduced. The dye is added to the milk and judgement is made based on the colour produced after a specified incubation time. High numbers of bacteria in the milk will remove the oxygen dissolved in the milk much faster so the dye becomes more discoloured than if the milk had only a few bacteria.

Procedure

- To prepare the resazurin solution, add one resazurin tablet to 50 ml of distilled water. Resazurin solution should not be exposed to sunlight or stored for more than 8 hours.
- With a sanitized dipper, transfer 10 ml of milk into a clean test tube.
- Add 1 ml of resazurin solution to the milk sample.
- Stopper the test tube and gently mix the dye into the milk.
- Mark the test tube and place it in a water bath at 37 degrees Celsius for 10 minutes.
- Remove the test tube from the water bath and put it in a Lovibond comparator with a resazurin disc.
- Compare the colour of the sample with a test tube containing 10 ml of milk but without the dye.



Judgement

Resazurin disc number	Colour	Grade of milk	Action
6	Blue	Excellent	Accept
5	Light blue	Very good	Accept
4	Purple	Good	Accept
3	Purple-pink	Fair	Separate
2	Light pink	Poor	Separate
1	Pink	Bad	Reject
0	White	Very bad	Reject

Gerber butterfat test

This test determines the fat content of milk. The fat content is then used to determine the price to be paid for milk supplied by the farmer. The test can also show whether the milk has been skimmed.

Procedure

- Add 10 ml of Gerber sulphuric acid into a butyrometer followed by 11 ml of milk and then 1 ml of amyl alcohol.
- Close the butyrometer with a rubber stopper and shake the butyrometer carefully until the curd dissolves and no white particles can be seen.
- Place the butyrometer in a water bath at 65 degrees Celsius for 5 minutes.
- Centrifuge for 5 minutes at 1100 rpm.



Apparatus for carrying out Gerber butterfat test



- Return the butyrometer to the water bath at 65 degrees Celsius for 5 minutes, ensuring the water level is high enough to heat the fat column.
- Read the butterfat percentage off the scale. If necessary, the fat column can be adjusted by regulating the position of the stopper.

Grading of milk

Milk that is received at cooling centres or processing plants is graded based on its quality. Grading helps in deciding whether to accept or reject the milk. The quality aspect may differ from country to country or dairy to dairy, but is generally based on one or a combination of the following:

- Butterfat content
- Bacterial count (microbial quality)
- Physical appearance (colour, smell, presence of dirt particles etc.)

Weighing of milk and payment

Once milk is accepted at the dairy or cooling centre, its weight is recorded. This must be done accurately because payment is often made per kilogram of milk delivered. Payment may also be made based on the fat content or microbial quality of the milk. Some dairies may pay a premium for good quality milk and penalize you for bad milk, so it is to your benefit if you can ensure that good hygiene is adhered to at all times when handling milk.



REMEMBER!

- ➔ Good hygiene practice in milk handling is the key to milk quality and safety.**
- ➔ Cooling milk will slow down the growth of spoilage bacteria and prolong the milk's shelf life.**
- ➔ But milk that already has many bacteria in it will not keep for long, even when cooled.**
- ➔ Good milk quality means good prices for your business.**



APPENDIX

Curriculum and minimum competencies for milk collection centre operators

Target Group	Course Title	Type of course & location	Course units (sessions)				
Milk collection centre operators	Hygienic milk collection and testing	Residential/on-site/outreach	Milk production				
Subunits	Objectives (Competency sought)	Course content	Duration		Training method/materials	Evaluation	Award
			Theory	Practical			
1. Hygienic milk production	Milk collection centre operators knowledgeable and skilled in hygienic milk production	Factors influencing milk quality Feeding Animal health Milking practices	1 hour		Lectures Discussions Questions & answers Participatory adult learning techniques	End of course theoretical written or oral test End of course practical test	Pass or fail
		Animal and udder health - zoonoses - mastitis	45 min				
		Hygienic milking	45 min	2 hours			
2. Hygienic milk handling	Milk collection centre operators knowledgeable and skilled in hygienic milk handling	Factors contributing to milk spoilage	½ hour		Lectures Discussions Questions & answers Participatory adult learning techniques		
		Types of milk handling & storage equipment	½ hour				
		Cleaning and sanitation agents	½ hour				
		Cleaning & sanitation of equipment	½ hour	1 hour			
3. Basic milk quality control and testing	Milk collection centre operators knowledgeable and skilled in milk quality control and testing	- Sight and smell (organoleptic) - Alcohol - Clot on boiling - Lactometer - Inhibitor test	1 hour	3 hours	Lecture Discussion Demonstration Hands-on testing		
4. Milk quality grading and payment systems	Milk collection centre operators knowledgeable and skilled in milk payment systems	- Resazurin test - Butterfat test - Weighing and recording - Grading and payment	1 hour	3 hours	Lecture Discussion Demonstration Overhead projector Flip chart Chalkboard Felt pens		
			6.5 hr	9 hr	End of course theoretical/oral ½ hour) and practical (1 hour) test	Certificate in basic milk quality control and testing	

Residential courses are carried out at training institution/milk collection centres for the entire duration of the course; on-site training involves shorter training sessions of 2-3 hours per day at a milk collection point/community centre over a period of 1-2 weeks to cover the 40-hour module. Outreach training involves BDS training provider conducting training sessions at or near clients' location for 1-3 days on continuous basis.



