STANDARD DAIRY AGENCY

GUIDELINES FOR THE INTERPRETATION **OF QUALITY PROBLEMS IN MILK**

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THE DAIRY STANDARD AGENCY

The Dairy Standard Agency (DSA) is an independent, non-profit entity promoting the improvement of quality and safety of milk and other dairy products at national level. The DSA plays a fundamental part in supplying relevant information to the primary dairy industry (milk producers), secondary dairy industry (milk processors) and retail sector.

The purpose of this guideline document is to assist the user in the identification of the cause of problems as well as the implementation of remedial action steps to limit the risk of recurrence. Food safety and quality trouble-shooting can only work if performed in the correct manner. This action becomes easier in the presence of properly maintained food safety and quality management programmes. One of the fringe benefits of orderly trouble-shooting, is the deeper understanding gained while applying theory and confirming practice. This can only take place as part of problem-solving.

This guideline document is by no means exhaustive, but will hopefully assist the user in gaining better insight.

The DSA wishes to thank Milk SA and the Dairy Quality Club members for their generous contributions to make this second edition possible. The Dairy Quality Club is a forum for suppliers who actively support the objectives of the DSA as an independent, objective institution.

TRAINING

One of the major causes of dairy food safety and product composition non-compliance is failure of adequate and appropriate training. It is a legal requirement that all food handlers are trained in food safety whether at milk production and processing level. The organised dairy industry has invested in industry specific training material in this regard. For more information regarding training contact:

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Trouble-shooting

1. MILK QUALITY

When the quality aspect of milk is addressed, it includes the nutritive value (e.g. fat and protein), shelf life as well as food safety aspects. Milk is, however, a highly nutritious food that is ideally suited for the growth of pathogenic and/or spoilage organisms. Substandard products originate from substandard facilities, processes and equipment. This can be rectified by adherence to relevant legislation and standards.

Food safety and quality start on the farm where the primary production of milk should be managed in a way that ensures safe milk which is suitable for its intended use. This document refers to milk destined for consumption and the following criteria are essential to ensure that practices and products conform to the relevant requirements:

- Good Agricultural Practices (GAP) through which threats to the environment are avoided.
- Good Veterinary Practices (GVP) through which contaminants, pests and diseases of animals and plants are controlled in such a way so as not to pose a threat to milk safety.
- Good Hygiene Practices (GHP) through which practices and measures are adopted to ensure that milk is produced under hygienic conditions.

All the raw milk delivered to a processor must originate from a milking shed that has a valid Certificate of Acceptability as stipulated in Regulation R961 of 2012 under *Foodstuffs, Cosmetics and Disinfectants Act*, 1972 (Act 54 of 1972). Furthermore, declarations from the state veterinarian of TB– and *Brucellosis*-free herds must be provided to the processor.

The quality of the raw milk intended for further processing, is the responsibility of the producer and processor and must be monitored during milk collection on the farm and at milk reception during raw milk intake at the facility. The processor's role in ensuring high quality and safe milk and dairy products, will include adherence to:

- A monitoring programme of raw milk quality intended for further processing.
- Implementation of acceptance and rejection criteria for raw milk.
- Good Manufacturing Practices (GMP) which include food safety and is part of a food quality assurance system. GMP can be referred to as a system of tools used to design and build safety and quality into the product. Product specification may serve as an example where the specification is a description of the requirements with which a product has to comply.
- Good Hygiene Practices (GHP) focus on personnel hygiene as well as effective cleaning and sanitation programmes for the equipment, buildings, etc.
- Good Laboratory Practices (GLP) are essential to ensure that all incoming raw milk as well as the final products adheres to the minimum legal product specifications.
- Good Distribution Practices (GDP) include the maintenance of the cold chain. This aspect is as important for dairy product quality and safety as the supply of safe and good quality raw milk.

Various regulations and standards relating to the production, marketing and labelling of food are in place to protect the South African consumer. These include:

- *The Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act 54 of 1972)"*
  - ☐ Regulations governing general and hygiene requirements for food premises and the transport of food and related matters (new regulation to be published 2017/2018).
  - ☐ Regulations relating to hygiene requirements for milking sheds, the transport of

milk and related matters (R961/2012).
  - ☐ Regulations relating to the labelling and advertising of foodstuffs (R146/2010).
  - ☐ Regulations relating to milk and dairy products (R1555/1997).
- *The Agricultural Products Standards Act,* 1990 (Act 119 of 1990).
  - ☐ R260 of 27 March 2015, Regulations relating to the classification, packing and marking of dairy products and imitation dairy products intended for sale in the Republic of South Africa.
- *SANS 10049. Code of Practice: Food hygiene management.*

The following summary may be used to simplify the interpretation of milk quality:

Specifications or quality parameters relating to food safety and consumer fraud

Quality specifications related to consumer fraud

- Water addition (freezing point) – Reference: R260.

Quality specifications related to food safety

- Inhibitors (antibiotics & antimicrobial substances) – Reference: R1555.
- Phosphatase (indication of effectiveness of pasteurisation) – Reference: R1555.
- *E. coli* – Reference: R1555.

Specifications or quality parameters relating to food quality and hygiene

Quality specifications related to hygiene

- Coliforms – Reference: R1555.
- Total Plate Count – Reference: R1555.

Specifications related to quality: Composition of milk

- Butterfat – Reference: R260.
- Protein – Reference: R260.
- Solids non-fat (SNF): R260.

2. THE QUALITY OF DAIRY PRODUCTS

Many hazards impact on the quality and safety of dairy products, from production to consumption and a number of strategies are needed to control these hazards.

The quality and safety of dairy products are important characteristics of milk and dairy products, both to the dairy industry and the consumers. This translates to nutritional value, conformance to legal requirements and the prevention of disease transfer as a result of consumption.

To achieve these quality attributes, we need to look at the complete dairy products processing chain. Once the milk is collected on the farms, care should be taken that the cold chain is not broken during transportation. Furthermore, the hygiene of the milk tanker is very important. A dirty tanker may be the source of bacterial contamination.

At the milk reception point, contaminants may come from the environment (e.g. water, air, personnel, dirty equipment, pests or waste). Good hygiene practices will ensure that microbiological hazards are not introduced at the reception area. There is also the possibility of hazards being introduced by a variety of contamination sources throughout the processing chain.

Contamination may be introduced from raw materials or supplies on the farm. Feed, for example may contaminate raw milk. Furthermore, internal sources of pollution may occur in the storage, processing and transportation environment. Various hygiene requirements must be met to prevent biological, chemical and physical contamination. Milk is a raw material and should contain only milk as an ingredient, with nothing added that may adulterate or contaminate it.

The objective of this booklet is:

- To provide background information on milk safety and quality; and
- To assist producers and processors in implementing corrective actions to correct the non-conformances that are identified in milk

2.1 Milk hygiene and quality

One general definition of quality is that "the consumer gets what he or she expects". Because quality is extremely important, milk producers and processors are increasingly required to ensure and prove that everything has been done to meet food safety and quality standards. If the producer and processor succeed in doing this, the consumer will have faith in the quality of the product, creating all-round benefits for every role player in the dairy value chain.

The quality of milk involves various different aspects.

- Physical quality
- Chemical quality
- Microbiological quality

The influences of hygiene on milk quality

2.1.1 Physical quality

Density, freezing point, osmotic pressure and acidity are examples of physical quality attributes. The density of normal milk varies between 1.028 and 1.038 g/cm^3 depending on the milk composition. The freezing point of milk is the only reliable parameter to check milk for dilution with water. Between individual cows, the freezing point has been found to vary from -0.54 to -0.59 °C. The acidity of a solution depends on the concentration of hydronium ions [H+] in it. When the concentrations of hydronium [H+] and hydroxyl [OH-] ions are equal, the solution is neutral (pH = 7). Fresh milk exhibits an average pH of 6.7.

2.1.2 Chemical quality

The different components of milk, especially fat and protein may undergo chemical changes during storage. There are normally three types of change affecting these components: oxidation, proteolysis and lipolysis. The products of these reactions can cause off flavours in milk and dairy products such as butter.

Flavour is not the only property of milk affected by light. Milk's nutritional value is also reduced by light. Milk is an important source of vitamin A and vitamin B2 (riboflavin). Both these vitamins are broken down when exposed to light. Riboflavin is particularly unstable in light. Thirty minutes of exposure to sunlight destroys up to a third of the riboflavin in milk.

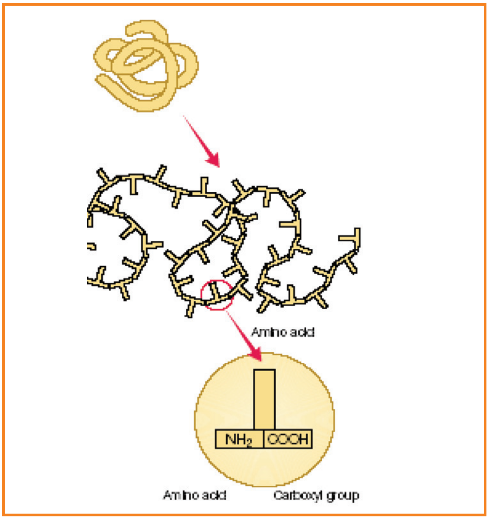
Oxidation

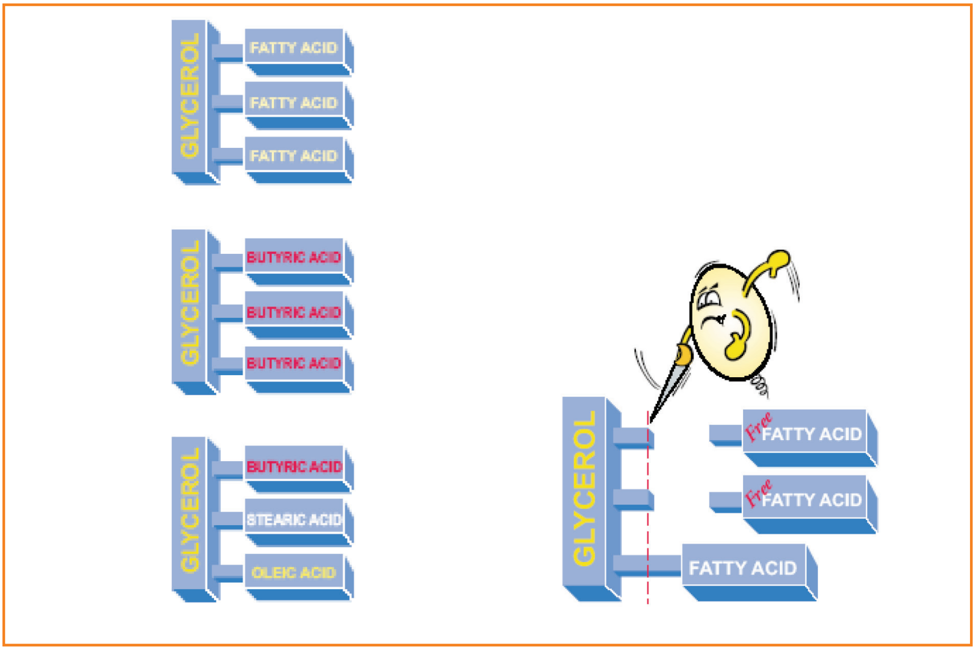
The oxidation of fat gives milk a metallic flavour, while giving butter an oily, tallow or cardboard taste. The presence of iron salts accelerates the onset of auto-oxidation and the development of metallic flavour, which is also caused by the presence of dissolved oxygen and exposure to light, especially direct sunlight or light from fluorescent tubes. Thus, both sunlight and artificial light destroy important vitamins in milk and can give it a musty, off-flavour.

When exposed to light, the amino acid methionine is degraded to methional. This is the principal contributor to the sour "sunlight flavour" or "scorched feather" taste. Higher temperatures also increase this reaction. Since methionine does not exist separately in milk, but is one of the components of milk proteins, fragmentation of the proteins must occur incidentally for the development of the sour flavour.

To avoid the oxidation of fat and protein in milk, the most important issue is to control contact with oxygen and direct sunlight. When the milk is stored prior to transportation, it must be protected from direct sunlight.

Lipolysis. The breakdown of fat into glycerol and free fatty acids, is called lipolysis. Lipolysed fat has a rancid taste and smell. High storage temperatures encourage lipolysis, but the responsible lipase cannot act unless the fat globules have been damaged. In normal farming and dairying routines there are many opportunities for fat globules to be damaged, for example by pumping, stirring and splashing the milk. Sharp edges and curves in milk tubes can also damage the fat globules.





Proteolysis: The enzymes responsible for proteolysis are known as proteases. Proteolysis of milk proteins can be attributed to both native proteases and the proteases produced by psychrotrophic bacteria during storage of fresh raw milk.

Proteolytic activity is elevated in milk with high somatic cell counts, giving rise to off flavours. Chemical and physical treatments of milk influence the proteolysis in milk.

There is a definite interaction between oxidation and proteolytic activity. Several studies have shown that milk can oxidise spontaneously, and that oxidation in milk depends on milk composition and storage conditions. Enhanced proteolytic activity in oxidised milk may therefore be responsible for at least part of the off-flavours characterised as oxidation by sensory panellists.

The proteolytic activity in milk also influences the quality of dairy products. For example, the presence of protease responsible for degradation of caseins in milk, can result in a reduction of cheese yields or bitter tastes in the cheese.

Good hygienic practices, good milking practices, maintenance of the cold chain and effective cleaning and sanitation of especially the bulk cooling tank on the farm, are essential to ensure that proteolytic activity does not negatively impact on the milk quality.

2.1.3 Microbiological quality

"Micro-organisms" is the collective term for microscopic living organisms (bacteria, yeasts and moulds) that are not visible to the eye. They are found everywhere – in the atmosphere, water and soil. There are thousands of micro-organisms that are species which are important to the existence and economic structure of human society. For example, during the breakdown of dead organic material, certain species form simple chemical elements that plants can then re-use. Since they break down organic material, micro-organisms play a very important role in the natural cycle.

Certain beneficial micro-organisms increase soil fertility and crop production, which results in a greater yield of harvested food. Some bacterial types also have great economic value as starter cultures (e.g. fermented milk products). Certain species are present in animal intestines and are essential for food digestion. However, micro-organisms can also have a negative influence on food quality and safety.

On the one hand food poisoning and infections caused by so-called pathogenic micro-organisms can be the result of poor microbiological milk hygiene. The presence of other types of micro-organisms can also result in the spoilage of milk or dairy products. These dangerous or undesirable microbiological aspects can be reduced by good hygiene practices, good agricultural practices and milk cooling.

Generally it can be assumed that a high bacterial count in raw milk results in a low quality product (e.g. off-flavours and lower shelf-life) and a less safe product (e.g. higher possibility of organisms that may cause infections).

2.2 Ensuring milk and dairy product quality

It is every primary producer's and secondary processor's responsibility to provide consumers with high quality milk and dairy products that are safe and nutritious. Analysing or testing the food that we consume for the presence of micro-organisms, is important. Although we do not test all food, food can be referred to as "safe" through proper audits. In many instances, the pathogenic micro-organisms are present in very small numbers, but for many of these pathogens, small numbers are all that are necessary to transmit disease or illness. For that reason, the presence of certain micro-organisms is monitored on a routine basis. These micro-organisms provide an indication of the hygienic quality of the product and may serve as indicators of possible presence of pathogenic species.

3. MICROBIAL COUNTS IN MILK

The significance of micro-organisms in milk

- Information on the microbial content of milk can be used to judge its sanitary quality and the conditions of production.
- If permitted to multiply, bacteria in milk can cause spoilage of the product.
- Milk is susceptible to contamination with pathogenic micro-organisms that may cause infections or produce toxins. Precautions must be taken to minimise this possibility and to destroy pathogens that may gain entrance.
- Certain beneficial micro-organisms produce chemical changes that are desirable in the production of dairy products such as cheese and yoghurt.

Milk obtained from a healthy udder by a healthy milker in a hygienic environment through the application of good milking practices, should not contain any pathogens or harmful (toxic) substances. Total bacterial counts of ≤ 10 000 colony forming units per millilitre (cfu/mL) milk, indicate that the milk was produced under good hygienic conditions.

Microbial contamination of raw milk by a variety of micro-organisms can coccur and may originate from various sources. Because of this, determining the cause of bacterial defects is not always clear and straightforward. High bacterial counts can result from one source, although they are often the result of a combination of factors (i.e. insufficient hygiene and marginal cooling). Other than the Total Plate Count (TPC) or Standard Plate Count (SPC), a number of testing procedures may be used to evaluate the quality of raw milk. These include the coliform group and *Escherichia coli* counts.

These tests are generally selected for bacteria that occur as contaminants and are not considered as the natural flora of the cow. Elevated counts would suggest that production practices and hygiene procedures on the farm are in need of improvement. The capability of these procedures to detect bacteria from different sources and causes, are summarised in ***Table 1***.

TABLE 1: SUMMARY OF POSSIBLE SOURCES OF MICROBIAL CONTAMINATION AS DETECTED BY SELECTED BACTERIOLOGICAL PROCEDURES

Procedure	Natural flora	Mastitis[1]	Dirty cows	Dirty equipment	Poor cooling
TPC >10 000	Not likely	Possible	Possible	Possible	Possible
TPC >100 000	Not likely	Possible (rare)	Not likely	Possible*	Possible*
Coliform count high	Not likely	Possible (rare)	Possible	Possible	Not likely but possible

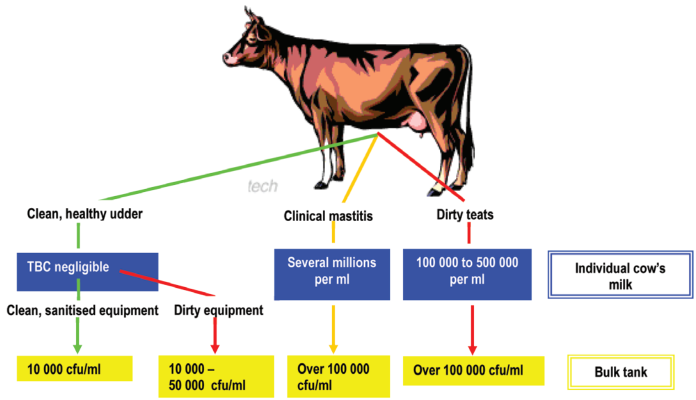
[1] Culturing for mastitis bacteria and SCC data would be useful
* A more likely possible cause

3.1 Sources of bacterial contamination in raw milk

The main sources of bacteria in raw milk are mastitis organisms from within the udder, organisms from the surface of the teats (*Figure 1*), organisms from the equipment, contamination from people handling the milk and organisms transported from the environment and air. Mastitis cows can produce milk with very high bacterial counts. The milk from an individual cow may contain millions of organisms per millilitre of milk. If allowed to go into the bulk tank, it may elevate the bulk tank milk count to well over 100 000 cfu/mL. The control of mastitis is important to ensure the production of raw milk with a low bacterial count. Dirty teats may also contribute up to a 100 000 cfu/mL. Good milking practices are needed to ensure that the raw milk is of a good bacteriological quality.

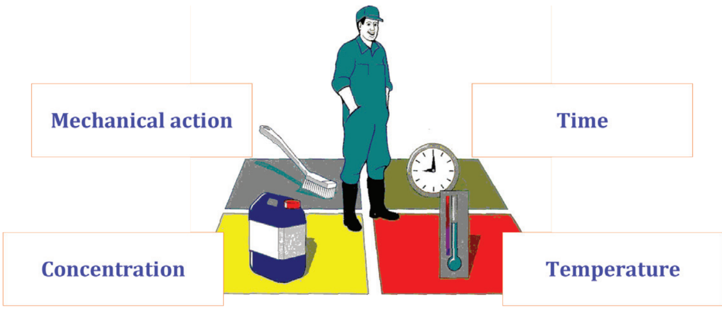
Bacteria deposited in/on the milking and milk-handling equipment will multiply and become a major source of contamination if the equipment is not cleaned and sanitised properly. Cleaning of milk handling equipment is accomplished by a combination of chemical, thermal and physical processes (*Figure 2*). A cleaning failure can result from a failure in any one of these processes.

FIGURE 1: Main sources of bacteria in raw milk



(*Adapted from*: Milk quality, ed. Harding, F.)

FIGURE 2: Main components in an effective cleaning and sanitising process



(*Source*: De Laval)

Ineffectively cleaned and sanitised (disinfected) surfaces or equipment containing old milk or milk residue will elevate the raw milk count by at least 10 000 cfu/mL.

In order to produce milk of a high bacteriological quality, good milking practices should be adhered to by the milker. The foremilk should be drawn off in a strip cup to check for the presence of mastitis clots (other sampling methods such as the California Mastitis Test or CMT, also apply).

The foremilk is likely to have a high bacterial count due to organisms entering the teat channel. Therefore, to control the spread of mastitis and prevent contamination, the foremilk should never be discarded onto the floor of the milking parlour. The in-line filters will remove the mastitis sediment, but bacteria associated with the disease will pass through the filter to the bulk tank.

Good milking practices also include a good post-milking routine.

3.2 Different groups of micro-organisms

There are many different types of micro-organisms that find their way into milk. The main group is bacteria, although yeast and moulds may also contaminate the milk.

The Total Plate Count (TPC) or Standard Plate Count (SPC) test provides an overall measure of milk quality, but has little diagnostic value in determining the source of bacterial contamination. The TPC should be less than 5 000 if the cow and equipment sanitation is sound and cooling is adequate. High bacterial counts may result from mastitis infection in the herd or cross contamination of milk contact surfaces. If the somatic cell count (SCC) and the TPC are both high, milk from the bulk tank should be tested to determine the type of mastitis organisms present in the milk. This information can be useful in managing mastitis in the herd.

Other types of bacteria represent contamination from the environment. These organisms are transferred during milking from the skin of the udder into the milk or from contaminated milk handling equipment. The bacteria multiply during the milking process and may continue to multiply between milkings if they are not removed or killed. During milking, bacteria enter the milk from contaminated contact surfaces and milk should be cooled to refrigeration temperatures as soon as possible to keep bacterial growth to a minimum.

3.2.1 Lactic acid bacteria (LAB)

Lactic acid bacteria are found on plants in nature, but some species occur in large numbers in places where there is milk. Others are found in the intestines of animals. The group includes both bacilli and cocci, which can form chains of varying length, but never form spores. Most are killed by temperatures of 70°C, although the lethal temperature for some is as high as 80°C.

Lactic acid bacteria prefer lactose as a source of carbon. They ferment lactose to lactic acid. The fermentation may be pure or impure, i.e. the end product may be almost exclusively lactic acid (homofermentative fermentation), or other substances may also be produced, such as acetic acid, carbon dioxide and ethanol (heterofermentative fermentation). If improper cooling of the raw milk takes place, high counts of streptococci will cause the milk to sour.

3.2.2 Psychrotrophic bacteria

A certain group of bacteria is called the psychrotrophs. These organisms are able to actively grow and multiply at temperatures lower than 7°C. This immediately creates a problem in the dairy industry due to the use of the cold chain. The psychrotrophs utilise proteins and fat for nutrients. In high numbers of >3 000 000 cfu/mL they can produce enough heat stable enzymes to cause flavour defects (e.g. fruity off-flavours). Although the micro-organisms are killed by effective heat treatment (pasteurisation), the heat stable enzymes survive the process and this leads to flavour defects in the milk or dairy product.

The most active psychrotrophs are *Pseudomonas* species. Their numbers in raw milk is of importance because of their ability to cause spoilage in milk and dairy products. *Pseudomona* isolates usually are environmental organisms, originating from water and soil. If present, they may indicate poor hygiene practices during milk production, especially cleaning and sanitising of the bulk cooling tank, or ineffective pasteurisation.

3.2.3 Spore-forming bacteria

Endospore-forming bacteria survive unfavourable conditions through the formation of this heat stable survival structure. *Bacillus* and *Clostridium* are examples of this group, also known as thermoduric organisms. They can withstand the high heat treatment used in the dairy industry. These organisms originate from plants or plant material (e.g. low quality silage) or soil and are introduced into the milk through poor hygienic practices. These organisms cause spoilage of the final dairy product. *Clostridium* causes late blow in especially cheddar cheese, while *B. cereus* may be the cause of sweet curdling in e.g. UHT milk. *Cl. tyrobutyricum* causes off flavours through the production of butyric and acetic acid.

3.2.4 Pathogens

Pathogens cause a food safety risk to consumers and may lead to foodborne diseases. They include *Staphylococcus aureus*, *Listeria*, *Salmonella*, *Mycobacterium tuberculosis* (TB) and *M. bovis* (from animals) as well as *Brucella abortus*. *B. abortus* may cause infection of man and may also be the cause of abortion in pregnant women. *S. aureus* is the main causative agent of mastitis but humans (e.g. milkers, food handlers) may also be carriers. Thus it may also be regarded as an indicator organism for hygiene practices. A certain strain produces an enterotoxin that may lead to food poisoning.

Listeria may be referred to as an environmental contaminant, while *Salmonella* is carried over by birds, humans (food-handlers) or faeces of cows. In certain cases cows suffering from salmonellosis, may shed the organism directly into the milk. Environmental sources of contamination may include dirty floors, drains and contaminated water.

In regulation R961 it is stipulated that all herds should be free from TB and *Brucellosis* (CA: contagious abortion). A milking parlour/shed should obtain TB– and CA-declarations, which need to be renewed periodically, certifying the herd free from these pathogens. Furthermore, all milk and dairy products need to be tested at least once a year for the presence of pathogens.

3.2.5 Indicator organisms

Coliform organisms are the indicators of hygiene practices. Causative sources of high coliform counts in raw milk are the udders, the environment and the personal hygiene of milkers. If the cleaning process is ineffective, high coliform counts will be reported. The coliform count thus provides an indication of both the effectiveness of cow preparation procedures during milking and the cleanliness of the cows' environment. Coliform counts of more than 100 cfu/mL are generally an indication of poor milking hygiene.

Coliforms will also incubate in residual films left on milk contact surfaces. Coliform counts in excess of 1 000 cfu/mL suggest growth or multiplication of organisms in milk-handling equipment. Coliform counts of less than 10 cfu/mL indicate excellence in both pre-milking hygiene and equipment cleanliness and sanitation. These organisms are killed by effective heat treatment. If they are present in pasteurised milk or dairy products, it can either indicate an ineffective pasteurisation process or a post-pasteurisation contamination point.

The most common sources of coliforms are dirty equipment and food contact surfaces as well as the hands of food handlers. Well-maintained and sanitised equipment and the implementation of good personal hygiene practices, will solve this problem.

E. coli can be referred to as a pathogen as well as an indicator of hygiene practices. The source can be an unclean, dirty udder, teats or environment or poor hygiene practices by the milker. In the factory food handlers' hands will be the source if they do not adhere to good personal hygiene practices. No *E. coli* may be present in raw milk intended for final consumption or dairy products.

3.2.6 Moulds and the production of mycotoxins

It should also be noted that moulds, mainly species of *Aspergillus* and *Penicillium*, can grow in milk and dairy products. If conditions permit, these moulds may produce toxins known as mycotoxins which can be a health hazard. The toxins are more often derived from contaminated feedstuffs.

Mycotoxins are some of the most toxic compounds/feedstuffs encountered within the food and feed industries. They are liable to occur in a variety of feedstuffs whenever such feedstuffs are kept under adverse conditions of temperature and humidity. Mycotoxin compounds are extremely stable and also dangerous in minute quantities – a few parts per billion are of concern. Once formed, they cannot be removed from the commodity concerned by processing or removal of visible mould growth, neither will they be destroyed by heat treatments.

Aflatoxins are produced by some members of the *Aspergillus* family of moulds. Of the twenty or so aflatoxins known (designated as B1, B2, G1 and G2), Aflatoxin M1 (a metabolite of B1 which passes into the milk of ruminants that have consumed aflatoxin contaminated feed) is likely to occur in dairy products.

Aflatoxins can be easily determined using various Elisa kits in analytical laboratories with the necessary facilities.

3.3 Effective cooling of milk

Even when good milking practices and strict hygienic practices are followed, there will be micro-organisms present in the milk. To ensure that the numbers do not increase, effective cooling of the raw milk after milking is needed. According to legislation R961 the milk has to be cooled down to <5°C within 2-3 hours after milking. This will inhibit the growth of the micro-organisms present.

These temperatures have to be maintained during collection, transportation and reception. During transport the temperature of the milk may not exceed 8°C.

3.3.1 Micro-organisms and growth temperatures

Most micro-organisms grow well at the normal temperatures favoured by man, higher plants and animals. However, certain bacteria grow at temperatures (extreme heat or cold) at which few higher organisms can survive. Depending on their preferred temperature range, bacteria are divided into the following groups:

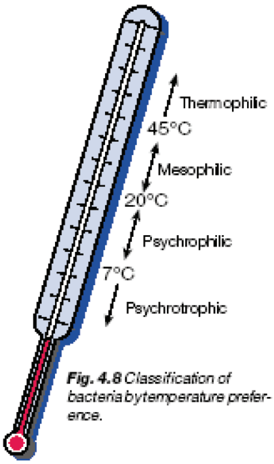


Fig. 4.8 *Classification of bacteria by temperature preference.*

GROUP	OPTIMUM GROWTH TEMPERATURE
Psychrotrophic	≤ 7°C
Psychrophilic	0°C - 20°C
Mesophilic	20°C - 45°C
Thermophilic	45°C - 60°C

- **Psychrotrophic** (cold-tolerant) bacteria are psychrophilic or mesophilic strains which can actively grow and reproduce at a temperature of 7°C or below, regardless of the optimum temperature.
- **Psychrophilic** (cold-loving) bacteria are mostly found in ice, snow and arctic regions and have an optimum growth temperature below 20°C.
- **Mesophilic** (moderate-temperature loving) bacteria are found in water, soil and in higher organisms and have optimum growth temperatures between 20-45°C.
- **Thermophilic** (heat-loving) bacteria have their optimum growth temperatures between 45-60°C.
- **Thermoduric** (heat-enduring) bacteria endure high temperatures – above 70°C. They do not grow and reproduce at high temperatures, but can resist them without being killed.

Psychrotrophic bacteria are of particular interest to the dairy industry, because microbiological activity in farm milk and market milk usually takes place at a temperature of 7°C or below.

3.4 Prevention of microbial contamination

During the handling of milk, bacteria from sources such as the inside and surface of the udder, the environment, the milkers and the equipment may enter the milk. The result is that the raw milk may contain very high numbers of micro-organisms. Good udder health and udder preparation is needed to prevent bacteria from entering the milk. At the factory or processing facility, dirty equipment (including silos) and food handlers are the biggest source of possible microbial contamination.

Aerial contamination is negligible under normal conditions. However, *Bacillus*, *Clostridium*, moulds and yeasts may use the aerial route to contaminate the milk. This may lead to low quality milk and milk products.

Water used in milking parlours and manufacturing facilities need to be of potable quality. If standards are not met, water treatment such as chlorination or ultra violet light (UV), should be considered.

All buildings and equipment need to be well-maintained to ensure that GMP and GHP can be adhered to. Effective cleaning, pest and waste removal programmes need to be put in place and recorded. Training programmes for personnel will inform them of the importance of good hygienic practices.

4. COMPOSITIONAL QUALITY OF MILK

4.1 Determination of the acidity of milk

4.1.1 pH

Raw cow's milk is slightly acidic, normally ranging in pH from 6.4 to 6.8. Mixed herd milk that is delivered for processing, is usually pH 6.6. A pH value higher than 6.8 may indicate mastitis infections, whereas values below 6.4 indicate the presence of colostrum or bacterial deterioration. Microbial souring can be related to as slight a pH change as 0.02 to 0.05.

Early detection of a pH change can provide useful processing information and ensure the quality of the milk throughout processing. Milk with deviating pH should be rejected at milk reception, as the heat stability most probably will be inferior. Sour milk may burn onto equipment surfaces during heat treatment causing failing during heat treatment.

The pH is a measure of the hydrogen ion (H+) activity in aqueous solutions. The most exact measure of pH is obtained electrometrically by means of a pH-meter. The pH in normal fresh milk from healthy cows is 6.6 ± 0.1. pH strips may also be used as an indicator of the pH, but is not always very accurate.

Possible reasons for a low pH may be:

- Milk not cooled to <5°C.
- Cold chain not maintained at <5°C.
- High bacterial load in milk.
- Acid detergents from cleaning programme in milk.

4.1.2 Titratable acidity (%TA)

Fresh raw milk does not contain lactic acid. Microbial activity can lead to the formation of lactic acid which will result in the souring of the milk. The acidity in milk is measured with a method where the acid is neutralised to determine the amount of acid already formed. For example, titration with a 0.1N NaOH solution indicates the consumption of NaOH necessary to shift the pH-value from 6.6 ± 0.1 (corresponding to fresh milk) to a pH-value of 8.2-8.4 (phenolphthalein).

The determination of "acidity" in fresh milk by means of titration, is therefore a measure of the buffer action of milk more than anything else. It is thus necessary to talk about the developed acidity, which is the result of bacterial activity producing lactic acid during milk collection, transportation, and processing. The developed acidity will be more pronounced if the milk is not cooled.

4.2 Antibiotics/Inhibitory substances

4.2.1 Antibiotics

Antibiotics are administered in therapeutic amounts to individual cows for specific diseases. Mastitis is the most common disease but infections, e.g. eye infections, may also necessitate the administering of medication. Antibiotics may, however, also be used as additives to feed and water in order to improve feed conversion.

In general antibiotic contamination of the milk generally occurs when cows are treated by intra-mammary infusion e.g. mastitis, injection of antibiotics e.g. footrot or treatment of teats with udder creams and ointments.

Possible causes of antibiotic contamination

- Not withholding the milk from the bulk vat for the prescribed time. This may be due to:
    - Poor identification of treated cows.
    - Poor communication between the milker(s) and person(s) actually treating the cow.
    - Insufficient knowledge of the withdrawal period.
    - Non-segregation of treated cows at milking, and milk residue from treated cows left in equipment.
    - Including milk containing antibiotics to ensure that the quota is maintained.

pH and % TA may be used in conjunction with the Alizarol test during intake of raw milk at milk reception

MILK	PH	%TA	FLOCCULATION	COLOUR
Fresh milk	6,66 - 6,75	0,14 - 0,16	None	Light purple
Slightly sour	6,30 - 6,50	0,17	Possible small flakes	Brownish-pink
Sour	6,00 - 6,20	0,18 - 0,19	Small flakes	Brownish-yellow
Very sour	<6,00	0,20+	Big/Large flakes	Yellow
Sweet coagulation	6,60-6,75	0,14 - 0,16	Big /Large flakes	Light purple
Mastitis	6,80 +	NA	Small flakes	Violet
Added alkaline chemicals	6,80 +	NA	None	Violet

- Antibiotic residue still being secreted in the milk after the prescribed withholding period.
- Poor udder preparation of cows treated with antibiotic ointments.
- Feeding medicated feeds.
- Recently purchased cows.
- Using two different treatments at the same time.

4.2.2 Inhibitory substances/ preservatives

- **Iodine:** High iodine levels in milk are generally caused by the use of iodine based sanitisers and teat dips. Iodine naturally occurs in low levels in all milk, but may increase if sanitisers are used above the recommended strength and machines and equipment are not properly drained. It is essential that iodine-based sanitisers, teat dips, udder creams and detergents are used in accordance with the manufacturer's recommendations. Sanitisers, teat dips, detergents and ointments not containing iodine are available.
- **Other preservatives:** If milk is of dubious microbiological quality an antimicrobial agent which acts as preservative may be added to the milk. This is also referred to as milk adulteration. The most commonly used preservatives include formaldehyde and hydrogen peroxide.

Adulteration of the milk by the addition of any preservative should be monitored closely and is prohibited by South African legislation.

4.3 Freezing point

A cryoscope or Milcoscan (analytical equipment) is used to determine the freezing point of raw milk on reception of the milk.

Cow's milk is a complex aqueous solution containing about 87,5% water and approximately 12,5% solids. The fat and proteins will hardly influence the freezing point of milk. The freezing point is therefore almost fully dependent on the milk salts and lactose concentrations with lactose accounting for ± 55% of the freezing point. Inadequate feed levels, poorly balanced rations and a mineral deficiency may also affect freezing point levels.

The freezing point of unadulterated milk is around -0,512°C. Adding water to milk raises its freezing point: the higher the freezing point (closer to 0°C), the more likely it is that the sample contains extraneous water.

The addition of water to milk may be accidental, but as little as 0,5% will influence the freezing point results. Failure to exclude the first milk which may contain water from the plant and failure to remove the rinse hose prior to any rinse water being used, are the two main areas where water is added to milk. Generally, the points to check when investigating a freezing point problem are:

- Ensure that all clusters are drained properly prior to milking. An air sweep of each cluster starting from the cluster nearest the releaser is of assistance.
- Ensure that the bulk tank is well drained prior to use.
- Ensure that all equipment such as coolers, releasers, milk pumps, cup removers, and main milk line are thoroughly drained prior to use.
- Ensure that the plate cooler is not leaking (check by running water without the milk flow) and that cooler rubbers are not damaged.
- Place teat cups on dry udders and do not wet udders or hose cows while cups are on the cow.
- Do not hose down the bulk tank while it contains milk.
- Do not dip teat cups in water or sanitising solutions between cows.
- Keep the first milk for calves.
- Make sure that the plate cooler is drained between milkings.
- In the processing facility all equipment needs to be well-drained.

4.4 Phosphatase test

Enzymes are organic catalysts which occur naturally in most raw foods. When milk is pasteurised most of the enzymes are inactivated or their activity is greatly diminished. The first reliable enzymatic test for determining efficiency of pasteurisation was developed by Kay and Graham in England in 1933. It was based upon the inactivation of the alkaline phosphatase enzyme in milk.

The phosphatase test is applied to dairy products to determine whether pasteurisation was done properly and also to detect the possible addition of raw milk to pasteurised milk. The thermal resistance of alkaline phosphatase has been considered to be greater than that of any non-sporeforming pathogens that might be found in milk.

Phosphatase tests are based on the principle that the alkaline phosphatase enzyme in raw milk liberates phenol from a disodium phenyl phosphate substrate (Scharer method) or phenolphthalein from a phenolphthalein monophosphate substrate (Rutgers method) when tests are conducted at suitable temperature and pH. The amount of phenol or phenolphthalein liberated from the substrate, is proportional to the activity of the enzyme. Phenol is measured colorimetrically after its reaction with 2,6 dichloroquinone-chloroimide (CQC) to form indophenol. Phenolphthalein is detected by addition of sodium hydroxide.

Reactivated phosphatase may sometimes be encountered in high-fat dairy products which have been ultra-pasteurised, such reactivation occurring quickly when samples are stored at non-refrigerated temperatures. A test has been developed permitting one to distinguish residual from reactivated alkaline phosphatase.

In combination with the coliform count, it can be used as a valuable trouble-shooting tool. If the coliform count is high and the phosphatase test is negative, it will indicate post-pasteurisation contamination. Should the phosphatase test be positive and high coliform counts are recorded, this will indicate ineffective pasteurisation of milk.

4.5 Milk-ring tests

The milk-ring test is an agglutination test performed on raw milk for the detection of bovine *Brucella*. This test (BM) is performed in the DSA monitoring programme on raw milk samples.

4.6 Somatic cell count

Dairy cows face continual exposure to bacteria capable of causing many diseases, including mastitis. A key element of mastitis control involves bacteria control. This includes maintaining a clean environment to limit exposure to environmental pathogens, minimising cow-to-cow transfer of contagious mastitis organisms at milking time and keeping cows healthy so they can effectively fight off challenges. There are practical limits on minimising exposure to bacteria and inevitably cows face challenges.

Healthy cows have a well-developed immune system to help protect against bacterial infections. Specialised somatic cells, produced by the immune system, normally can be mobilised quickly in the event of a bacterial challenge. These cells are transported by the bloodstream to the infection site. They can pass through blood vessel walls into infected areas and have the tools to find and kill invading bacteria and protect the body. While there are several types, as a group they are referred to as white blood cells, leukocytes or somatic cells.

Somatic cells in milk can be both friend and foe. Their numbers in milk provide a solid indication of udder health status. Generally somatic cells function with little notice. Occasionally, during a severe mastitis challenge, the number of somatic cells and cellular debris cause noticeable changes in the physical characteristics of milk including clots, flakes etc. Electronic cell counters used by milk quality labs, allow somatic cell concentrations in raw milk to be determined quickly and accurately.

Milk somatic cell counts (SCC) are strongly correlated with udder infection status which, in turn, is related to production losses and milk quality issues. High SCC milk provides less casein for cheese production and the protein generally is of lower quality in terms of curd characteristics, etc. High SCC milk is also known to cause reduced shelf life in fluid milk. For both producers and processors these concerns translate into monetary losses.

Mastitis is a major cause of elevated cell counts and therefore mastitis control measures should be implemented. The most common pathogen causing sub-clinical mastitis is *S.aureus*. However, there are many other species that may cause infections.

If the bulk milk somatic cell count is higher than desired, the following information may be of some assistance:

A. Raw milk sample evaluation

- Conduct full quarter milk sample evaluation which include somatic cell count and bacteria identification.

B. Maintain milking machines and equipment

- Machines have to be serviced annually or immediately if teat condition deteriorates.
- Refer to assistance if teat cups slip more than five times per 100 cows per milking.
- Ensure effective pulsation by choosing the correct teat cup liners and maintaining full squeeze phase for at least 15% of the pulsation cycle.

C. Milk correctly

- Keep udders clean.
- Attend to lanes and gateways.
- Clip tails and udders if necessary.
- Put cups on clean dry teats.
- Do not use cloths between cows. Use only disposable paper towels to dry udders.
- Cut the vacuum before removing the cups gently.

D. Disinfect teats after milking

- Use freshly prepared teat disinfectant at recommended strength all year round.
- Use only glycerine (emollient) as a teat skin softener, but not above 10%.
- Be sure to get complete coverage of teats.

Handling existing infections

A. Treat clinical cases

- Use an antibiotic recommended by a veterinarian.
- Use the full course of treatment according to label.
- Clearly mark treated cows and withhold milk for the recommended period.

B. Treat at drying off

- Treat all quarters of all cows at drying off when there is no reliable method of selecting infected cows.
- Treat all quarters of any cow with clinical mastitis record or with a cell count above 250 000.
- Clean and sterilise teats before treating with a high dose antibiotic in a long acting base, then dip teats after treatment.

C. Cull chronic cases

- Cull cows that have more than three clinical cases per lactation.
- Cull cows that do not respond to dry cow therapy.
- Ensure that cows recently treated are not culled for slaughter.

Monitoring progress with control programme

A. Record treatments given

- Keep a record of each cow and quarter treated.
- Monitor the number of clinical infections that occur and the treatment administered.
- Record the antibiotic used.
- Confer with veterinarian to ensure correct treatment and antibiotic is used.

Identify sub-clinical cases

The following checks to ensure good milking practices, can control the onset of mastitis:

Milking machine

- Vacuum pump
- Vacuum regulation
- Vacuum gauge
- Pulsator
- Cups and liners
- Claws
- Releaser
- Rubberware
- Maintenance and servicing

Milking management

- Clean surrounding environment
- Udder preparation
- Cow and udder health
- Teat condition
- Cup application
- Prevent overmilking
- Cup removal

Teat disinfection

- Type of disinfectant
- Skin conditioners
- Preparation of teat dip
- Application of teat dip
- Residuals

Treating clinical mastitis

- Effectiveness of treatment
- Choice of medicine
- Method of treatment
- Supportive treatment

Dry cow therapy

- Selecting cows for treatment
- Administration of dry cow therapy

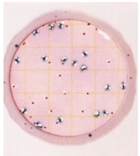
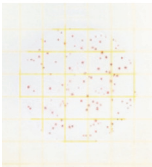
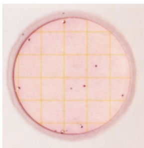
Identification of sub-clinical mastitis

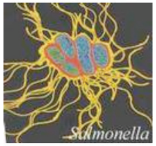
- Bacterial culturing
- Somatic cell counts
- Rapid mastitis test
- Electric conductivity
- Enzyme assay

Record-keeping

- Cows treated
- Quarter treated
- Antibiotic used
- Bulk tank counts
- Somatic cell counts.

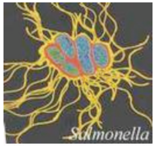
1. POSSIBLE PROBLEM AREAS RELATED TO MICRO-ORGANISMS IN RAW MILK FOR FINAL CONSUMPTION

ANALYSES	SOURCE OF CONTAMINATION	SOURCE OR REASON
Violet Red Bile MUG Agar Petrifilm 	***Escherichia coli (E. coli)*** This organism is an indicator of faecal contamination due to poor hygiene practices as well as poor milking practices. It is also a potential pathogen that may cause illnesses and may not be present in the milk according to regulations	• Faecal contamination from dairy animals • Poor hygienic practices (poor hand washing practices – human faeces) • Poor milking practices including lack of fore milking, incorrect use or no replacement of sock filters and incorrect or no use of teat plugs • Poor water quality • Poor hygiene during collection of milk
Standard Plate Count Agar Petrifilm 	**Total plate count (TPC) or standard plate count (SPC)** This is a basic quality test measuring the total number of bacteria in the milk. It reveals general sanitation and herd health conditions. **Legislation** ≤ 200 000 *cfu/mL for raw milk intended for further processing ≤ 50 000 *cfu/mL for raw milk intended for final consumption	• Improper cleaning and disinfection of milking equipment • Lack of maintenance on milking equipment • Improper cooling of the milk (bulk tank and during transportation) • Poor milking practices including lack of fore milking, incorrect use or no replacement of sock filters and incorrect or no use of teat plugs • Improper udder preparation • Poor animal health • Poor water quality
Violet Red Bile Agar (can be performed in combination with E. coli on VRB MUG Agar) Petrifilm 	**Coliforms** This procedure is a more specific bacterial test for the quality of the milk. It is an indicator of proper sanitation. High counts can be caused by poor herd hygiene, improperly washed and maintained equipment, or a contaminated water supply. **Legislation:** ≤ 20 cfu/ml raw milk for final consumption; (VRB MUG agar method.)	• Indicator organism of poor hygienic practices • Poor hygiene practices of milkers • Improper cleaning and disinfection of milking equipment leading to residual films on milk contact surfaces. (Implementation of effective cleaning programme in conjunction with chemical supplier, correct volume of water, chemical dosage, temperature and time) • Improper cleaning and disinfection of bulk tank • Poor udder preparation • Poor water quality • Absence of or improper cooling of milk • Sub-standard cleaning chemicals used for cleaning

ANALYSES	ORGANISM	SOURCE OR REASON
Various methods for patho-gens  	***Salmonella*** There is a widespread occurrence of the organism in animals, especially in poultry and swine. Environmental sources of the organism include water, soil, insects, factory surfaces, animal faeces and raw animal products. ***Salmonella*** may cause salmonellosis in consumers. Although the illness is commonly referred to as "food-poisoning", the resulting gastro-enteritis is an infection of the small intestine with no involvement of pre-formed toxins. **Legislation:** Absent in raw milk for final consumption.	• People, birds and animals (faecal contamination) • Contaminated plant material • Poor health status of herds • Poor personal hygiene • Poor hygienic practices • Poor milking practices • Poor water quality (borehole/untreated water used in cleaning equipment)
S. aureus on Baird Parker agar 	***Staphylococcus areus:*** Certain staphylococci produce enterotoxins, which may cause food poisoning at numbers exceeding 10^6 /ml milk or dairy product. This ability to produce enterotoxins, is usually limited to those strains that are coagulase-positive. *S. aureus* is also a major causative agent of mastitis. ***Legislation:*** Absent in raw milk for final consumption	• Poor personal hygiene • Poor health status of herd (mastitis caused by *S. aureus*) • Poor hygiene practices • Poor udder health/preparation (cross contamination between cows) • Poor milking practices
	Listeria monocytogenes: This is a bacterium common to the environment that is capable of causing serious human disease. Listeriosis is the general name given to a variety of illnesses caused by ***L. monocytogenes***. Certain population groups are at risk for serious illness, e.g. pregnant women (cause of miscarriages), toddlers, the elderly, and people with weakened immune systems. **Legislation:** Absent in raw milk for final consumption	• Contaminated plant material, feed • Poor environmental status – organism present in the air • Poor hygienic practices • Poor milking practices • Poor water quality (e.g. borehole/untreated water for washing equipment) • Stagnant water

2. POSSIBLE PROBLEM AREAS RELATED TO MICRO-ORGANISMS IN PASTEURISED MILK

ANALYSES	ORGANISM/LEGISLATION	SOURCE OR REASON
Violet Red Bile MUG Agar Petrifilm	***Escherichia coli (E. coli):*** This organism is an indicator organism of poor hygienic practices and is also a potential pathogen that may cause illnesses. It is killed by effective pasteurisation and may not be present in pasteurised milk according to regulations.	• Faecal contamination due to poor personal hygiene practices • Poor hygienic practices due to poor hand washing practices • Poor water quality • Poor packaging practices • Poor cleaning and disinfection programmes
Standard Plate Count Agar Petrifilm	**Total Plate Count (TPC) or Standard Count** This is a basic quality test that is a measure of the total number of bacteria in the milk after pasteurisation. **Legislation:** ≤ 50 000 cfu/mL for pasteurised milk intended for final consumption	• Poor raw milk quality • Improper cooling of raw milk in silo's • Improper cleaning and disinfection of milk processing equipment as well as cooling equipment • Lack of maintenance on milk processing equipment • Insufficient time/temperature combination during pasteurisation • Improper cooling of the milk after pasteurisation • Ineffective cleaning and disinfection programme • Poor water quality
Violet Red Bile Agar (can be performed in combination with ***E. coli*** on VRB MUG Agar) Petrifilm 	**Coliforms** This procedure is a more specific bacterial test for the quality of the milk. It is an indicator of proper sanitation. High counts can be caused by poor hygiene practices, improperly washed and maintained equipment, or a contaminated water supply. **Legislation:** ≤ 10 cfu/mL for pasteurised milk intended for final consumption	• Ineffective pasteurisation or post-pasteurisation contamination • Indicator organism of poor hygienic practices • Poor hygiene practices of food handlers (poor hand washing practices) • Improper cleaning and disinfection of milk processing equipment, pipelines, cooling and packaging equipment • Improper maintenance of milk processing equipment, pipelines, cooling and packaging equipment • Contaminated packaging material • Poor manufacturing practices • Break in cold chain during dispatch, transportation or in retail–absence or improper cooling • Poor water quality

ANALYSES	ORGANISM/LEGISLATION	SOURCE OR REASON
Various methods for pathogens  	***Salmonella:*** There is a widespread occurrence of the organism in animals, especially in poultry and swine. Environmental sources of the organism include water, soil, insects, factory surfaces, animal faeces and raw animal products. **Salmonella** that may cause salmonellosis in consumers. Although the illness is commonly referred to as "food-poisoning", the resulting gastro-enteritis is an infection of the small intestine with no involvement of pre-formed toxins. **Legislation:** absent in pasteurised milk	After pasteurisation contamination: • People, birds and animals (faecal contamination) • Ineffective pest control • Contaminated packaging material • Poor health status of food handlers • Poor personal hygiene • Poor hygienic practices
Standard Plate Count Agar Petrifilm 	***Staphylococcus areus:*** Certain staphylococci produce enterotoxins, which may cause food poisoning at numbers exceeding 106/ml milk or dairy product. This ability to produce enterotoxins, is usually limited to those strains that are coagulase-positive. *S. aureus* is also a major causative agent of mastitis. **Legislation:** Absent in pasteurised milk	After pasteurisation contamination: • Poor personal hygiene • Poor health status of food handlers • Poor hygiene practices
	Listeria monocytogenes: This is a bacterium common to the environment that is capable of causing serious human disease. Listeriosis is the general name given to a variety of illnesses caused by ***L. monocytogenes.*** Certain population groups are at risk for serious illness, e.g. pregnant women, toddlers, the elderly, and people with weakened immune systems. ***Legislation:*** Absent in pasteurised milk	After pasteurisation contamination: • Poor environmental status – organism present in the air • Condensation from pipes contaminating product during packaging • Poor hygienic practices • Poor water quality

3. ANTIBIOTICS OR INHIBITORY SUBSTANCES IN RAW/PASTEURISED MILK FOR FINAL CONSUMPTION

Various methods are used to determine the presence of antibiotics or inhibitory substances in milk, e.g. Delvotest, Charm, Rosa, βetaStar, Copan Milk Test. These inhibitory substances enter milk mostly through animal therapeutic substances/treatments.

Legislation: Amounts not exceeding the *Maximum Limits for Veterinary Medicine and Stock Remedy Residues Regulations*

ORIGIN/CAUSE	SOLUTION
A. RAW MILK Milk from treated animals enters bulk tank before end of withdrawal time: ■ No permanent written records of treatments ■ Forgetting animal was treated ■ Poor identification of treated animals ■ Poor communication between person who treats and person who milks animals ■ All milk from all quarters of treated animal not kept out of bulk tank ■ Milkline used as a vacuum source to treated animal when using trap bucket to withhold milk ■ Separate milker unit for treated animals not used ■ Milker unit not cleaned properly between treated and untreated animals ■ Dry and treated animals not separated from the milking herd	The primary producer (farmer) has to be informed of the problem **On the farm** • Keep a permanent record of all treatments • Mark all treated animals in an easily recognised manner • Post-treatment information on bulletin board to ensure people milking are aware of treated animals and appropriate withdrawals • Discard milk from all quarters of treated animals • Check with equipment supplier whether present pulsator can be adapted to provide vacuum to trap bucket • Milk treated animals last or with separate equipment • Thoroughly clean milker unit between treated and untreated animals • Use antibiotic test where appropriate • Separate dry cows from the milking herd
Prolonged drug withdrawal time – antibiotics used in extra-label fashion: ■ Antibiotic drugs used at a higher dosage and/or more frequently ■ Administering of other livestock medicines ■ Administered by a route different from label recommendations ■ Antibiotic drugs not approved for use in lactating dairy cattle are used	• Use approved livestock medicines; follow prescription • Use appropriate antibiotic tests • Store medicated feeds for non-lactating dairy cattle separately from milking herd feed
Feeding medicated feeds	• Get a CoA from feed suppliers • Medicated feeds for non-lactating dairy cattle should be stored separately from the milking herd feeds
Animals' udders treated with antibiotic ointments, dips and sprays	• Use only approved products • Follow recommended withdrawal times
B. PASTEURISED MILK Inhibitory substances in pasteurised milk	• Processor to implement antibiotic testing on all raw milk received • Implement an effective sanitising programme which will ensure proper rinsing of pipelines or equipment in the manufacturing facility. • All other inhibitory substances are added intentionally to pasteurised milk

4. ABNORMAL FREEZING POINTS IN RAW MILK

The freezing point is determined with the use of a cryoscope and a lactometer can be used to check the solids. The adulteration of milk with water is not allowed by legislation. This may negatively influence the quality of the milk or dairy product.

ORIGIN/CAUSE	SOLUTION
Additional water in raw milk due to: ■ The deliberate addition of extraneous water to milk ■ Negative or inadequate pipeline slope ■ Incomplete draining of milking equipment (receiver jars, milk hoses, claws, meters, wash manifolds and jetter cup assemblies) before milking ■ Incomplete drainage of bulk tank ■ Inadvertent addition of water by "chasing" or "sweeping through" with water at end of milking ■ Water pipeline connected to bulk tank during wash cycle ■ Careless dipping of clusters between milking of cows ■ Accidental onset of automatic cleaning-in-place system before the bulk tank is emptied or the pipeline is diverted ■ Poor milking practices	• Address problem with primary producer (farmer) • Adjust pipeline to a positive slope • Check all equipment before milking to ensure all water has drained out • Check that the bulk tank is fully drained before closing end valve • Remove pipeline from bulk tank before rinsing • Install safety switch to ensure that CIP starts after bulk tank is emptied • Review post milking practices

5. ABNORMAL FREEZING POINTS IN PASTEURISED MILK

Additional water in pasteurised milk due to: ■ Deliberate addition of extraneous water by primary producer ■ The deliberate addition of extraneous water to milk in processing facility ■ Negative or inadequate pipeline slope ■ Incomplete draining of milking processing equipment and pipelines ■ Poor manufacturing practices substances in pasteurised milk	• Analyse individual samples of suppliers daily • Identify processing facility and address problem with processor • Adjust pipeline to a positive slope • Check all equipment to ensure all water has drained out • Adhere to good manufacturing practices

6. PHOSPHATASE TESTS FOR PASTEURISED MILK

The Aschaffenburg and Mullen Test is used. This test is performed on pasteurised milk to ensure that proper pasteurisation has been performed on all heat treated milk and dairy products. A fluorometric procedure is used for the analysis and an alkaline phosphatase reading of less than 500mμ/l must be obtained.

■ Ineffective pasteurisation (wrong time/temperature combination) ■ Too large a volume of milk is sent through the pasteuriser ■ Faulty heat treatment equipment (e.g. no flow diversion valve) ■ Holes in pasteurisation plates (raw milk and pasteurised milk are mixing) ■ Raw milk was added to pasteurised milk ■ Faulty thermometer	• Adjust minimum temperature of pasteuriser • Ensure that correct volume of milk is sent through the pasteuriser • Ensure that all heat treatment equipment is well maintained and in working order • Perform dye test on pasteuriser • Avoid adulteration/cross contamination of pasteurised milk with raw milk • Implement thermometer calibration programme

7. QUALITY TESTS: BUTTERFA, PROTEIN AND SNF

The results of the quality tests need to be interpreted against the legislation in the Agricultural Products Standards Act (Table 1 of R260 of 2015:

CLASSES OF AND STANDARDS FOR PRIMARY DAIRY PRODUCTS OTHER THAN CHEESE AND BUTTER

Type of primary dairy product	Class/Class designation	Alternate class designation	Milk fat content (%)(m/m)	Minimum milk solids non-fat content		Minimum milk protein content calculated on a fat-free basis (%) (m/m)	pH value at 20 – 25°C	Maximum freezing point (°C)
				Calculated on the total content (%) (m/m)	Calculated on a fat-free basis (%) (m/m)			
1	2	3	4	5	6	7	8	9
Milk	High fat milk		More than 4.5	8.2	8.6	3	6.6 – 6.85	-0.512
	Full fat milk	Full cream milk; Whole milk; Milk	More than 3.3 – 4.5	8.3	8.6	3	6.6 – 6.85	-0.512
	Medium fat milk	X% Medium fat milk; X% Medium cream milk	More than 1.5 – 3.3	8.4	8.6	3	6.6 – 6.85	-0.512
	Low fat milk		More than 0.5 – 1.5	8.5	8.6	3	6.6 – 6.85	-0.512
	Fat free milk	Skim(med) milk	Not more than 0.5	8.6	8.6	3	6.6 – 6.85	-0.512

8. OFF FLAVOURS IN RAW MILK

Sensory evaluation is sometimes used to determine the acceptability of the milk. The following can be used as guidelines to determine the possible source of the off-flavours.

TYPE OF OFF FLAVOUR	ORIGIN/CAUSE	SOLUTION
Malty/sour	Bacterial action because of ■ Poor cooling ■ Unclean milking equipment	• Cool milk down quickly to <5 degrees C (1st milking is especially critical) • Keep all milking and cooling equipment clean and sanitised • Replace old rubber parts
Oxidised	Oxidation of milk fat ■ Water used for cleaning that is high in iron, copper or sulphur (>0.1ppm) ■ Excessive use of chlorine sanitisers or equipment that was inadequately drained ■ Milk was exposed to sunlight and/or artificial light ■ Unclean milk contact surfaces ■ Excessive air incorporation, agitation and foaming	• Change water source or treat the water if necessary • Do not exceed 200 ppm chlorine in the sanitising solution • Ensure proper drainage of equipment • Store and transport milk away from direct sunlight/artificial light • Ensure an effective cleaning and sanitising programme for milk contact surfaces • Adjust speed of bulk tank stirrer, repair air leaks of inlet valves on pipelines and milk pumps, avoid oversize air inlets on milking claws, check that milk is not being pumped excessively from receiver jar

TYPE OF OFF FLAVOUR	ORIGIN/CAUSE	SOLUTION
Rancid	■ Slow cooling ■ Milk freezing in the cooler ■ Excessive air incorporation, agitation and foaming ■ Large number of stale animals (e.g. over 300 days in milk) ■ Ration low in protein	• Check cooling time of bulk tank • Avoid milk freezing in the bulk tank • Adjust bulk tank paddle (if possible) to reduce speed • Repair air leaks of inlet valves on pipeline, receiver jar and milk pump • Avoid oversize air inlets on milking claws • Check that milk is not being pumped excessively from receiver jar • Dry off stale animals • Balance ration for adequate protein
Unclean, barny, cowy, mouldy	■ Poorly ventilated barns ■ Dirty cattle and/or barns ■ Coliform, mould or yeast contamination ■ Unclean milking equipment ■ Poor milking practices ■ Cattle feed is musty or mouldy	• Ventilate barn properly • Keep stables clean, including calf pens and maternity/ sick pens, but do not clean them out while milking • Keep cattle clean and clipped – especially flanks and udders • Keep all equipment clean and well-maintained. • Do not feed dusty/mouldy feeds
Bitter	■ Weeds, rancidity ■ Old ensiled feeds (e.g. old silage/haylage at the bottom of silos)	• Keep feed as weed-free as possible • Do not feed old ensiled feeds to the milking herd

Dairy Quality Club Members

The quality chain of dairy products is extensive and requires appropriate control throughout the value chain to ensure that end product will comply with legal standards and satisfy the needs of the consumer. For this reason, it is imperative that input suppliers commit themselves to quality and/or food safety standards regarding their products used in the process of dairy production, processing, packing, storage and distribution.

The primary objective of the Dairy Standard Agency (DSA) is to promote the improvement of dairy quality and safety on a national level in the interest of the industry and the consumer. The DSA recognises the important role and contribution of input supplier companies, which service the dairy industry with high-quality products and integrity and is desirous to collaborate with such companies through the DSA Dairy Quality Club. The Dairy Quality Club is a forum of suppliers that support the initiatives of the DSA as an independent objective institution.

Purpose of the Dairy Quality Club

- To assist and encourage stakeholders in the dairy industry purchasing from input suppliers that maintain product integrity and high standards.
- To enable the DSA to identify potential suppliers to the dairy industry who will enhance the quality and safety of the manufacturer's products.
- To create a technical platform from which recommendations can be made regarding dairy technical information.

Dairy Quality Club Directory

3M South Africa

3M Food Safety provides a large portfolio of proven and reliable solutions to meet your testing needs. Products are designed to help you maximize accuracy, consistency and efficiency and supported by worldwide sales and technical services second to none. - www.3m.co.za

bioMérieux

Global leader in *in vitro* diagnostics for more than 50 years, and in more than 150 countries through 42 subsidiaries and a large network of distributors, bioMérieux provides diagnostic solutions that improve patient health and ensure consumer safety. - www.biomerieux.com

Dairypack

Dairypack is your one-stop shop for dairy packaging with a full range of lightweight dairy containers for fresh and long life milk, drinking yoghurt, dairy juice or traditional maas and sorghum beer. - www.dairypack.co.za

Deltamune

The Deltamune Dairy laboratory offers a wide range of tests at affordable prices. A biotechnology company focusing on veterinary and public health solutions, mainly for the production animal sectors. - www.deltamune.co.za

Lake Foods

Lake Foods is the exclusive representative for leading international manufacturers and suppliers of speciality ingredients and commodities, offering products and services into the dairy, beverage, wine, meat, bakery, health and nutrition industries. - www.lake.co.za

Mérieux NutriSciences

As one of the longest-established commercial food testing laboratories of its kind in South Africa, Mérieux NutriSciences provides a comprehensive product-safety service to the food and beverage, cosmetics, hospitality and related industries throughout the SADC region. - www.merieuxnutrisciences.com/za

Diversey

Diversey's purpose is to protect and care for people every day. Diversey has been, and always will be, a pioneer and facilitator for life. We constantly seek to deliver revolutionary cleaning and hygiene technologies that provide total confidence to customers across all our global sectors. These include: facility management, health care, hospitality, retail and food service; in addition to food and beverage. Diversey is a provider of cleaning, sanitation and maintenance products, systems and services that efficiently integrate chemicals, machines and sustainability programs. Everything we do is based on the implicit belief that cleaning and hygiene are life essentials and that what we undertake constitutes a vital service. - www.diversey.com/diversey-food-beverage/agriculture/diversey-hygiene-products/deosan-agricultural-hygiene-products

Tetra Pak

Tetra Pak is the world's leading food processing and packaging solutions company. We provide safe, innovative and environmentally sound products that each day meet the needs of millions of people. - www.tetrapak.com/za