



Science

## **HYGIENIC PRACTICES AND BACTERIOLOGICAL QUALITY OF MILK: A REVIEW**

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### **Abstract**

Anyone dealing with raw milk on a day-to-day basis knows very well how quickly it becomes sour when it is stored for long periods at high ambient temperatures prevalent in tropical and subtropical countries. This is because the inherent lactic acid bacteria and contaminating microorganisms from storage vessels or the environment break down the lactose in milk into lactic acid. When sufficient lactic acid has accumulated, the milk becomes sour and coagulates, much like when you add sufficient lemon juice to fresh milk. Raw milk that contains too much lactic acid, even if it does not appear to be curdled, will coagulate when heated. So far, many pathogenic microorganisms, such as *Escherichia coli*, *Listeria monocytogenes*, *Staphylococcus aureus*, *Salmonella sp.*, and *Candida sp.*, have been reported as the causal agents of food-borne diseases and/or food spoilage. Contamination of raw and/or processed foods usually occurs during the production, sale, and distribution of the foods. Therefore, the objective of this review paper was to investigate hygienic practices and bacteriological quality of milk. In order to produce good quality dairy, establishment of standards, use of effective enforcement, education of dairy personnel's and farmers on various aspects of milk hygiene and handling technique is important.

**Keywords:** Hygiene; Bacteriological Quality and Milk.

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### **1. Introduction**

The public health experts have defined milk as to be "the lacteal secretion of the mammary glands of a mammal, practically free from cholesterol, obtained by the complete milking of one or more healthy cows which contains not less than 8.25% milk solids-not-fat, and less than 3.25% milk fat" (Woldecherkos and Yitayal, 2003). As it is well known, milk is the first natural food of all young mammals during the period immediately after birth (Yirsaw, 2004). It is used to nourish the young from birth to weaning, and it is the most complete food product of animal origin providing more

essential nutrients in significant amounts than any other single food (Mirkena, 2010). The use of milk and milk products as human food has got a very long history. The milk as it is meant to be the first and sole food for offspring of mammals - is an almost complete food (Pandey and Voskuil 2011).

The composition of milk is extremely complex, consisting chiefly of water, protein in colloidal suspension, lactose and fats in emulsion, inorganic salts in solution, vitamins, enzymes, gases and other substances (Woldecherkos and Yitayal, 2003). Milk is an outstanding source of calcium and phosphorus for bones and teeth, and contains riboflavin, vitamin B1, vitamin B6, vitamin B12, and vitamin A in significant amounts (Yirsaw, 2004). As milk products play an important role in human nutrition throughout the world, consequently, the products must be of high quality. In less developed areas and especially in hot tropics high quality of safe product is most important but not easily accomplished (Mirkena, 2010). Milk and milk products have an immune enhancing property, particularly for the benefit of HIV/AIDS affected people. In addition, milk contains various properties, which make it easy to convert into different milk products or to use it as an ingredient for other food items (Pandey and Voskuil, 2011).

The safety of raw cow milk is influenced by a combination of management and control measures along the entire dairy supply chain. Control of animal health, adherence to good milking practices, and control over milking parlour hygiene are important in reducing the microbial load in raw milk (FSA, 2006). All foods have the potential to cause food borne illness, and milk and milk products are no exception. Dairy animals may carry human pathogens. Such pathogens present in milk may increase the risk of causing food borne illness. Moreover, the milking procedure, subsequent pooling and the storage of milk carry the risks of further contamination from man or the environment or growth of inherent pathogens (CAC/RCP, 2004)

The safety of dairy products with respect to food-borne diseases is a great concern around the world. This is especially true in developing countries where production of milk and various dairy products take place under rather unsanitary conditions and poor production practices (Zelalem and Faye, 2006). Also, the composition of milk makes it an optimum medium for the growth of microorganisms that may come from the interior of the udder, exterior surfaces of the animal, milk handling equipment and other miscellaneous sources such as the air of the milking environment (Workuet *al.*, 2012). Milk has nutrients that make it suitable for the rapid multiplication of bacteria that cause spoilage. Unhygienic production, poor handling and undesirable practices such as addition of water or other substances can introduce bacteria or germs that cause spoilage (Paul *et al.*, 2004).

Diseases that commonly spread from the milk to human beings are tuberculosis, brucellosis, salmonellosis, listeriosis, campylobacteriosis, yersinosis, and other bacterial pathogens transmitted to humans include *streptococcus agalactaciae*, *staphylococcus aureus* and *Escherichia coli* (Mirkena, 2010). Milk may contain both pathogenic and nonpathogenic organisms. Pathogenic organisms, which may come directly from the cow's udder, are species of *Staphylococcus*, *Streptococcus*, *Mycobacterium*, *Brucella*, *Escherchia*, *Corynebacterium*, etc. Various other pathogenic causing diseases like cholera and typhoid may find access in the milk from various other sources, which may include water, and the persons handling the milk.

Nonpathogenic microflora may come directly from the udder and may also enter in the milk from milker's hands, utensils, cow barn, water, etc. (Yirsaw, 2004).

Therefore; the objective of this paper is to provide an overview on the hygienic practices and bacteriological quality of raw milk.

## **2. Hygienic Practices and Bacteriological Quality of Milk**

### **2.1. Hygienic Practices of Milk**

#### **2.1.1. Hygienic Practices Followed During Milk Production**

Because of the important influence of primary production activities on the safety of milk products, potential microbiological contamination from all sources should be minimized to the greatest extent practicable at this phase of production (primary). It is recognized that microbiological hazards can be introduced both from the farm environment and from the milking animals themselves. Appropriate animal husbandry practices should be respected and care should be taken to assure that proper health of the milking animals is maintained. Further, lack of good agricultural, animal feeding and veterinary practices and inadequate general hygiene of milking personnel and equipment and inappropriate milking methods may lead to unacceptable levels of contamination with chemical residues and other contaminants during primary production (CAC/RCP, 2004).

Milk is an ideal balanced diet for human beings. It is not surprising therefore that it also provides an ideal medium for growth of bacteria. Bacteria find accidental access to milk may give rise to consumer's health problems or product faults. Bacteria produce enzymes, which attack fat, protein or lactose and some of these enzymes even survive in milk after the bacteria have been killed by heat treatment, hence affecting the quality of pasteurized milk. Bacterial contamination of milk can all be minimized by starting the manufacturing process with raw milk of good hygienic quality (Mirkena, 2010).

Milk when it emerges from a healthy udder contains only a very few bacteria. However, milk is a perishable product. It is an ideal medium for micro-organisms and as it is a liquid, it is very easily contaminated and invaded by bacteria. Almost all bacteria in milk originate from the air, dirt, dung, hairs and other extraneous substances. In other words, milk is mainly contaminated with bacteria during milking. It is possible to milk animals in such a clean way that the raw milk contains only 500 to 1,000 bacteria per ml. usually the total bacteria count after milking is up to 50,000 per ml. However, counts may reach several millions of bacteria per ml. That indicates a very poor hygienic standard during milking and the handling of the milk or milk of a diseased animal with i.e. mastitis (Pandey and Voskuil, 2011).

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, you need to practice good hygiene during milking and when handling the milk afterwards (Lore *et al.*, 2006). Production of quality milk is a complicated process (Pandey and Voskuil, 2011). It is the concern of so many stakeholders, which include:

Dairy farmers;

- Dairy cooperatives;
- Milk and milk product processors;
- Retail distributors (shopkeepers and super markets);
- Consumers of dairy products;
- State regulatory departments;
- Extension staff and veterinarians.

An efficient hygiene program should begin at the farm. Essentially milk hygiene practice has interests in preventing the transmission of disease from animals to man, preventing the transmission of communicable diseases of man through milk, preventing diseases or physical defects that may arise from malnutrition and improving the nutritional status of man in general and of infants, children, and mother in particular (Barbuddhe and Swain, 2008).

Good quality raw milk must be:

Free from debris and sediment;

- Free from off-flavours;
- Low in bacterial counts;
- Normal composition and acidity;
- Free of antibiotics and chemical residues;
- Safe for human consumption and free from disease producing microorganisms;
- High in keeping quality;
- High in commercial value;
- Can be transported over long distances.

Therefore, good hygiene is essential whether the animals are milked by hand or machine (Barbuddhe and Swain, 2008). This requires that:

- The milkers' hands and clothes are clean and he or she is in good health.
- The milking machine and milk storage equipment such as milk churns are kept clean and are in good condition.
- Immediately after milking, the milk must be cooled preferably to 4°C. This requires mechanical refrigeration or milk cooling tanks.

### ***2.1.2. Milking Procedure***

It is important to remember that quality control must begin at the farm. That way, the milk will have fewer bacteria that cause spoilage and diseases. In order to ensure good quality and protect the health of consumers, one must always carry out milking in accordance with good hygienic practice (Lore *et al.*, 2006). Follow these rules on the correct procedures of milking by hand

A good milking technique is essential for the production of safe, raw milk (FSA, 2006):

- Teats, udder and adjacent parts must be clean before cluster attachment.
- Teat dips/sprays must be used in accordance with manufacturer's instructions.
- Milk from each animal must be examined at each milking.
- When identified, abnormal milk must be kept separate and not used for human consumption.

- Milk from animals showing clinical signs of udder disease must be kept separate and not used for human consumption.
- Animals producing milk that is unfit for human consumption must be clearly identified.
- Milking equipment must be kept clean at all times.
- Hands must be cleaned before milking and kept clean during milking and milk handling. Exposed skin wounds must be hygienically covered.

### ***2.1.3. Sanitary Practices of Milk and Milk Products Handling Equipment***

#### ***2.1.3.1. Cleaning of Milk Handling Equipment***

The milk house is a critical place on a dairy farm for maintaining sanitation to produce high quality milk. The milk house is where the milk is brought from the barn by pipeline, cooled and stored. A milk house may also have a utility room, storage room, or office space. Milk houses contain a bulk tank for storing the milk, a milk receiver jar where the pipeline empties, a filtration device, in-line cooling equipment, automatic cleaning controls, and a place to wash and store milking equipment (Janniet *al.*, 2007). The decision to produce quality milk rests primarily with the dairy producer. The efforts of service personnel and consultants will not be effective without this intention and commitment on the part of the producer. The motivated dairy producer needs competent support service to achieve her/his goal (Reinemann, 2001).

A very important item of the milk transport business is the vessel in which the milk is carried (Kurwijila, 2006). In addition, all milk handling vessels should be washed and disinfected immediately after use as follows:

- Pre-rinse with clean potable water
- Thoroughly scrub the container with warm water and detergent/soap using a suitable brush or scouring pad (do not use steel wool or sand!)
- Rinse the container with clean running water
- Immerse the container in boiling water for at least one minute
- Sun dry the container upside down on a drying rack

## **2.2. Bacteriological Quality of Raw Milk**

Milk is a highly nutritious food that serves as an excellent growth medium for a wide range of microorganisms. Fresh milk drawn from a healthy cow normally contains a low microbial load (less than 1000 cfu/ml milk) but the load may increase up to 100 times fold, or more, once it is stored for some time at normal temperature (Arafa, 2013). Milk being a major constituent of human diet, can serve as a good medium for the growth of many microorganisms especially bacterial pathogens, therefore its quality control is considered essential to the health and welfare of a community (Edward, and Inya, 2013).

### ***2.2.1. Sources and Significance of Bacterial Contamination on Different Level of Raw Milk Production***

The bacterial contamination in milk emanates from a number of sources including mastitis, external udder surfaces and from the milking plant (Mirkena, 2010). Milk is virtually a sterile fluid

when secreted into alveoli of udder. However beyond this stage of production, microbial contamination might generally occur from three main sources; within the udder, exterior to the udder and from the surface of milk handling and storage equipments, but the surrounding air, feed, soil, feces and grass are also possible sources of contamination (Mosuet *al.*, 2013). Microorganisms are mainly transferred from the farm environment to milk via dirt (e.g. faeces, bedding and soil) attached to the exterior of teats. In addition, microorganisms attached to the exterior of the teats can enter the teat canal and cause mastitis. Finally, contamination can originate from insufficiently cleaned milking equipment when, during milking, microorganisms adhered to surfaces of the milking equipment are released into the milk (Vissers and Driehuis, 2008).

Inadequate cooling of the milk, improper udder preparation methods, unclean milking equipment and the water used for cleaning purposes are considered as the main source of milk contamination (Yirsaw, 2004). In order to produce milk of good bacteriological quality, dairy farmers should be aware of the sources of contamination and importance of proper milk handling, cooling and storage.

### **2.2.1.1. Interior of The Udder**

#### **Healthy Udder**

For many years, it was believed that milk drawn directly from the udder of a healthy cow was a sterile fluid, that is, it contained no living microorganisms (Yirsaw, 2004). It starts its journey in the udder of a mammal as a sterile substance, but as it passes out of the teat, it is inoculated by the animal's normal flora. Being a nutritionally balanced food stuff with a low microbial load (less than 10000ml-1) when drawn from the udder of a healthy cow, milk gets contaminated at various stages including the cow itself, the milker (manual as well as automated) i.e. the milker's hand or milking equipment, storage vessels and water supply particularly when used for adulteration (Edward and Inya, 2013).

It has been demonstrated; conclusively that freshly drawn milk usually contains bacteria (Yirsaw, 2004). The numbers of bacteria, which are present in freshly drawn milk, vary with individual animals, quarters of the udder, environment of the animal (cleanliness of quarters), health of the animal, and other factors. Raw milk as it leaves the udder of healthy cows normally contains very low numbers of microorganisms and generally will contain less than 1000 total bacteria per ml (Murphy, 1996). Natural flora within the udder of healthy animals is not considered to contribute significantly to the total numbers of microorganisms in the bulk milk, nor the potential increase in bacterial numbers during refrigerated storage. Natural floras of the cow generally have little influence on standard plate counts (SPC) (Yirsaw, 2004)

#### **Infected Udder**

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. In case of mastitis counts of *Streptococci*, *Staphylococci* or coliforms will be as high as the total plate count and can be very high up to  $10^7$ cfu/ml. Bulk milk count may even increase to  $10^5$ cfu/ml under certain circumstances (Yirsaw, 2004).

Table 1: Show some of the pathogenic bacteria of public health significance from infected udders of cows.

<b>Pathogenic bacteria</b>	<b>Remark</b>
<i>Mycobacterium bovis</i> / <i>Mycobacterium tuberculosis</i>	Tuberculosis
<i>Brucella abortus</i> / <i>Brucella melitensis</i>	Brucellosis
<i>Coxiella burnetii</i>	Q-fever
<b>Infected Udder</b>	
<i>Staphylococcus aureus</i>	Enterotoxin
<i>Escherichia coli</i>	Some serotypes pathogenic to man, fecal contamination
<i>Streptococcus agalactiae</i>	fecal contamination Pathogenicity for man uncertain
<b>Infected udder minor</b>	
<i>Leptospira</i> spp	Other source (feces, poor silage)
<i>Listeria monocytogenes</i>	Other source (feces, poor silage)
<i>Bacillus cereus</i>	Survive pasteurization, other sources
<i>Clostridium perfringens</i>	Survive pasteurization, other sources

Source: Yirsaw, (2004).

### 2.2.1.2. The Exterior of the Udder

The exterior of the udder can be an important source of contamination. But the exterior of the udder is influenced by the environment of the cows, in which cows are housed and milked (Yirsaw, 2004). The bacteria which are naturally present on the skin of animal enter into milk from the surface of the udder and teats; these also include the bacteria which are present in milking and housing places of animals (Ali et al., 2011).

### Housing Conditions

In temperate regions, cows are housed in winter and pastured in summer. Differences in teat contamination can be found between housing and pasturing. Both total plate and aerobic spore counts are lower when cows are at pasture. When cows are housed, bedding material and feed stuffs can be contamination sources. In both cases (housing and pasturing) feces and dung are also an important contamination sources. Contamination of bedding material can be very high due to absorption of urine and feces (Yirsaw, 2004).

### Teat Contamination

The exterior of the cows' udder and teats can contribute microorganisms that are naturally associated with the skin of the animal as well as microorganisms that are derived from the environment in which the cow is housed and milked (Nangamso, 2006). Microorganisms are mainly transferred from the farm environment to milk via dirt (e.g. faeces, bedding and soil) attached to the exterior of teats; in addition, microorganisms attached to the exterior of the teats can enter the teat canal and cause mastitis (Vissers and Driehuis, 2008).

The groups of microorganisms isolated from teats are mainly Micrococci and aerobic spore formers. The method of sampling teats can give different results but in general most bacteria found

are aerobic spore formers. This can be a problem in producing milk in that the spores may survive pasteurization temperatures and spoil the milk and milk products during storage (Bacillus spores) and semi-hard cheese during ripening (clostridial spores). Teat surfaces are also sources of clostridial spores in milk. Sources of these spores are feed stuff, silage and bedding. The number declines markedly when cows go out to pasture because the pasture environment is cleaner than housing conditions (Yirsaw, 2004).

### **Udder Preparation**

Careful cleaning of the cow prior to milking significantly reduces contamination. Clipping the flanks, escutcheon, and udder reduces contamination from hair and adhering debris. A maximum reduction of teat contamination of 90 % can be achieved with good udder preparation (washing with disinfectant and drying with paper towel) before milking. This depends on the initial level of contamination and the way of udder preparation. So with high initial contamination levels this 90 % reduction might not be reached (Yirsaw, 2004).

#### ***2.2.1.3. Milking and Storage Equipment***

Contamination of milk via the milking equipment occurs when (a) microorganisms adhere to surfaces of the milking equipment and (b) milk residues that remain in the equipment after the cleaning cycle. Under these conditions, growth of adhered microorganisms may occur, especially in cracked and decayed rubber parts that are sensitive to accumulation of microorganisms. During the next milking, adhered microorganisms can be released into the milk (Vissers and Driehuis, 2008).

Thorough cleaning of dairy utensils and equipment is essential. Anyone handling milk must also pay great attention to hygiene. Lack of hygiene can contaminate milk with other types of bacteria, which turn it sour and reduce its storage life (Pauline and Karin, 2006). The utensils and equipment used during milking should be made of non-absorbent, corrosion-resistant material. The surface should be smooth, have minimal joints or open seams and should be free from dents (Pandey and Voskuil, 2011).

### **Cleanings and Disinfections of Milk**

There are various types of cleaning and sanitation agents that have been specially designed to clean and disinfect milk-handling equipment (Lore, *et al.*, 2006). First wash the utensils with hot water and a detergent. A clean brush with good bristles should be used, which is only designated for the cleaning of the milk equipment. Detergents are necessary to clean milking equipment effectively before disinfection. The effectiveness is increased when warm water is used. This helps to displace milk deposits and to remove dirt, dissolve milk protein and emulsify the fat. Disinfectants are required to destroy the bacteria remaining after washing and to prevent these subsequently from multiplying on the cleaned surfaces. Also, their effectiveness is increased with temperature. Sufficient contact time should be allowed with the surfaces to be cleaned and disinfected (Pandey and Voskuil, 2011).

### **Storage of Raw Milk**

Having limited the number of bacteria entering milk during milking, it is essential that contamination from equipment situated between the cow and the refrigerated storage unit is kept



to a minimum. Bacteria are present in the air, dust and water, especially any water containing traces of milk residues which may have been left in the milking plant overnight, as such residues provide a very good source of food for bacteria, thereby enabling the bacterial counts to increase rapidly. Cleaning regimes are based on removing visible dirt, removing milk residues (fat, protein, milk stones) which harbour bacteria, then sterilization of the cleaned surfaces using heat or chemical sterilants such as sodium hypochlorite (Nangamso, 2006). In tropical conditions, raw milk, i.e. non-pasteurised milk, goes off within a few hours. It must therefore be kept cool and quickly pasteurised and again cooled to a temperature of 4°C if possible (Pauline and Karin, 2006).

#### ***2.2.1.4. Miscellaneous Sources of Bacteria in Raw Milk***

Poor hygiene often arises from poor handling, and common sources of bacterial contamination, include faeces, personnel, and containers. Additionally, the hygienic quality of milk may be affected seriously by adulteration with contaminated water. Such interferences also reduce the compositional, nutritional, and processing quality of milk (Donkoret *al.*, 2007). Microorganisms may contaminate milk at various stages of milk procurement, processing and distribution. The health of the cow and its environment, improperly cleaned and sanitized milk handling equipment, and workers who milk cows come in contact with milk due to a number of reasons could serve as sources of microbial contamination of milk (Mirkena, 2010). The soils, while the cows are in pasture, manure, the animal coats, tails etc. are some of the possible sources of contamination of milk. Substances such as salt, water, etc., added to various dairy products, may be a source of microorganisms in large or small numbers, and of harmless or harmful types (Yirsaw, 2004).

### **2.3. Cooling of Milk**

Effective milk cooling is essential to ensure the quality of the product (CTP, 2006). If the milk is cooled to 4 °C within a period of 2 – 3 hours after milking, it maintains nearly its original quality and remains good for processing and consumption. However, in rural areas it is hardly possible to achieve this. Simple alternatives are putting the container with milk in water or placing a moist cloth around the metallic milk containers. Other possibilities are solar powered coolers or a charcoal box which is moistened to reduce the milk temperature (Pandey and Voskuil, 2011). In the tropical countries of Africa with high ambient temperatures, lack of refrigeration facilities at the farm and house hold level imply that raw milk will acidify very fast unless and otherwise protected. Therefore, the collection systems must be designed to move the milk to the cooling and/or processing center in shortest possible time. In addition, every effort should be made to use available systems such as water cooling, air circulation or shaded areas to reduce milk temperature (Yirsaw, 2004).

### **2.4. Bacterial Quality Test**

Farmer groups and operators of milk collection points and centers need systems of quality control for the milk they receive from individual farmers. This enables segregation of poor-quality milk at collection centres. Several simple tests, if carried out judiciously and consistently, will enable the milk collection centre to ensure that only good quality milk is accepted for onward transportation to milk processing factories, milk bars or retailers of raw milk in urban centers (Kurwijila, 2006). These tests are routinely carried out at milk collection points 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 (Lore *et al.*, 2006).

#### **2.4.1. Dye- Reduction Tests**

These tests are less precise criterion for classifying raw milk according to its bacteriological quality. This calls for the need to periodically verify the quality of milk with more precise microbiological tests such as standard plate count (Yirsaw, 2004).

##### **2.4.1.1. Methylene Reduction Test**

The length of time milk takes to decolourise methylene blue is a good measure of its bacterial content and hence of its hygienic quality. This time period is governed primarily by the activity of the reducing bacteria present in the milk plus the oxygen content. When the oxygen has been utilised the methylene blue is reduced, changing in colour from blue to white (C.B. O'Connor, 1995).

Methylene blue is a blue-colored reagent which is used to estimate the bacterial population of a given milk sample. A known dilution of the methylene blue solution is added to the milk sample and observation is made at fixed intervals until the blue color disappears. The number and species of organisms present in the milk determines the time required for the disappearance of the blue color in the milk (Teka, 1997). Normally if the number of bacterial organisms is greater, the time required to decolorize the blue color is shorter. This test is usually used for grading the quality of raw milk before pasteurization. On the basis of this test, raw milk is graded as follows (Yirsaw, 2004):

- Very good: not decolorizing in 5 hours.
- Good: decolorized in less than 4 hours, but not less than 3 hours.
- Fair: decolorized in less than in 2 hours, but not less than 1 hour.
- Poor: decolorized in less than ½ hour.

##### **2.4.1.2. Resazurine Reduction Test**

This test is also used for grading the sanitary quality of raw milk by applying the chemical reagent Resazurine (Yirsaw, 2004). This test is based on the reduction of the oxidation/reduction indicator Resazurine to Resorufine and finally to dihydroresorufine. Resazurine imparts a blue colour to milk which when reduced to resorufin changes to pink and finally to white when reduced to dihydroresorufin. The test is a good indicator of the bacteriological quality of milk (C.B. O'Connor, 1995). The time required for complete decolorization, reduction of the Resazurine and the degree of colour change is directly related to the number of bacterial organisms in the milk. A comparator disc reading value of 4 and above for 10 minutes Resazurine test indicates good quality but while a comparator disc reading value of less than 4 at 10 minutes indicates poor quality milk (Yirsaw, 2004).

#### 2.4.2. 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 Clot on boiling test and organoleptic 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 (Lore *et al.*, 2006). The stability of casein in milk depends partly on the degree of hydration of the casein particles. Development of acidity in milk causes partial dehydration of the casein micelles. When acid levels are high enough, the addition of an equal amount of 68 per cent alcohol to milk will lead to further dehydration and destabilization of casein and cause the milk to clot. The alcohol test can detect milk whose pH is 6.4 or lower and is more sensitive than the clot-on-boiling test which only detects milk pH levels of 5.8 and below. Colostrum and mastitis milk may give a positive alcohol test (Kurwijila, 2006).

#### 2.4.3. Standard Plate Count Test (SPC)

Throughout the world, official regulatory standards for milk are based on determination of bacterial numbers present in raw milk. The SPC is the official regulatory test used for estimating bacterial populations of raw milk and milk products and is the official reference method specified in the Grade A Pasteurized Milk Ordinance (PMO). The PMO requires the SPC to be less than 100,000 cfu/ml for Grade A farms; grade B milk regulations require the SPC to be less than 300,000 cfu/ml (united states) (Pamela L. Ruegg and Douglas J. Reinemann, 2002).

As there are numerous different kinds of bacteria in milk, the test focuses most directly on those bacteria that can grow in the presence of oxygen at 32 degrees Celsius. Other tests can more specifically count different bacterial populations when identified problems need to be resolved. The legal limit for the Plate Loop Count is 50,000 per ml, though producers should be able to keep their counts below 5,000 on a regular basis. High counts are usually due to improper cleaning and sanitizing of milking equipment, as well as inadequate cooling (SCCAHL, 2010). Milk samples are plated on standard plate count agar media and then incubated for 48 hrs at 32oc to encourage bacterial growth. Single bacteria or clusters grow to become visible colonies that are then counted. All plate counts are expressed as the number of colony forming units (cfu) per milliliter (Yirsaw, 2004). Plate count standards have been developed to ensure satisfactory production hygiene and that the product is safe (Table 3). The plate count method has been conducted as a valuable adjunct to guide sanitarians in correcting sanitation failures and improving milk quality (Yirsaw, 2004).

Table 3: Grade of raw milk based on SPCSource: Yirsaw, (2004).

Bacterial count/ml	Grade
Not exceeding 200,000	Very good
200,000 – 1,000,000	Good
1,000,000-5,000,000	Fair
>5,000,000	Poor

#### **2.4.4. Coliform Bacteria in Raw Milk**

Coliform counts are performed by culturing dilutions of raw milk on selective media such as violet red bile agar. The plates are incubated at 90F (32C) for 24 hours. The source of Coliform bacteria in bulk tank milk is the udders of cows or unsanitary milking practices. The Coliform count is an indication of the effectiveness of cow preparation procedures during milking and the cleanliness of the cows' environment. Coliforms can also incubate on residual films of milking equipment. The Coliform count should be less than 10 cfu/ml. A Coliform count between 100 and 1000 usually indicates poor milking hygiene and a Coliform count >1000 suggests that bacterial growth is occurring on milk handling equipment (Pamela L. Ruegg and Douglas J. Reinemann, 2002).

#### **2.4.5. The Somatic Cell Count (SCC)**

Somatic cells are composed of white blood cells (WBC) and occasional sloughed epithelial cells. Cells found in normal bovine milk from uninfected glands include neutrophils (1 – 11%), macrophages (66 – 88%), lymphocytes (10 – 27%) and epithelial cells (0 – 7%). The macrophages have an important role in providing surveillance in the uninfected gland. When bacteria invade and colonize the mammary gland, the macrophages respond by initiating the inflammatory response that attracts polymorphonuclear cells (PMNs) into the milk to engulf and destroy the bacteria. The largest factor that influences the SCC of milk is mastitis. The SCC of a cow that is not infected with mastitis is usually less than 200,000 cells/ml and many cows maintain SCC values of less than 100,000 cells/ml (Pamela L. Ruegg and Douglas J. Reinemann, 2002).

An increased number indicates an increase in mastitis in the herd either due to infection or traumatic factors. The regulatory level is 500,000 per ml for the bulk tank, but producers should be able to keep their counts below 200,000 on a regular basis. High somatic cell counts decrease the quality of the milk, as well as indicating financial losses to the producer as infected cows do not produce as much milk as healthy ones. A legal standard has been established at 1,500,000 per ml, but it is recognized that measurements can vary from breed to breed (SCCAHL, 2010).

#### **2.4.6. Titrable Acidity Test**

In order to determine the sourness of milk, we use titration using sodium hydroxide (NaOH) and the degree of sourness is given by Soxhilet-Henkel Degree (SH<sup>0</sup>). Generally the sourness of normal milk is 6 to 7 SH<sup>0</sup>. If the milk sourness is 4 to 5 SH<sup>0</sup>, it indicates that either the milk is adulterated or there is mastitis (Yirsaw, 2004).

#### **2.4.7. Phosphate Test**

The enzyme phosphatase in milk is destroyed by the temperature-time conditions used for pasteurization (63°C for 30 minutes or 72°C for 15 seconds). Detection of the enzyme phosphatase indicates inadequate pasteurization of milk and thus some degree of risk of pathogen infection (Kurwijila, 2006).

The phosphatase test is the most important public health measure for controlling the efficiency of pasteurization, hence the safety of milk. Phosphatase is an enzyme, which is normally present in

raw milk. When milk is pasteurized by any of the recognized processes, the enzyme is completely inactivated. Therefore, a positive phosphatase test will indicate that the milk is not properly pasteurized. It may mean any one of the following (Yirsaw, 2004).

- The pasteurization temperature time combination was not strictly observed or
- The pasteurization equipment was not functioning properly or
- The pasteurized milk has been contaminated by raw milk.

This is important because improperly pasteurized milk still could transmit tuberculosis, brucellosis, and Q fever (Yirsaw, 2004).

#### **2.4.8. Other Milk Quality Tests**

##### **2.4.8.1. Organoleptic Tests**

This test is performed first and involves assessing 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 the tester 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 (Lore *et al.*, 2006). The organoleptic test should be the first test to be carried out on all milk received at the collection centre and poor quality milk should be immediately rejected, obviating the need to proceed with other quality control tests (Kurwijila, 2006).

##### **2.4.8.2. Sedimentation Test**

It is a visual measurement of the amount of filterable sediment that exists in raw milk. Most sediment is cleaned up by the milking system filters. If however, there is a problem with the filters or an excess of sediment, then it can appear in the bulk tank (SCCAHL, 2010).

##### **2.4.8.3. 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 (Lore *et al.*, 2006).

##### **2.4.8.4. Lactometer Test**

This test is used to determine if the milk has been adulterated with added water or solids. Addition of anything to milk can introduce bacteria that will make it spoil quickly. Adulteration of milk is dishonest to consumers and is therefore illegal. Most lactometers are usually marked from “0” (representing density of 1.000 g/ml) to “40” (representing density of 1.040 g/ml) (Lore *et al.*, 2006).

The test is based on the fact that the density of whole milk ranges from 1.026 to 1.032 g/ml. Adding water to milk lowers its density, while addition of solids increases the density of milk. A lactometer

is the equipment that is used to measure the density of milk, and any deviation from the normal range would indicate that the milk has been adulterated (Kurwijila, 2006).

### 3. Conclusions and Recommendations

The poor hygienic conditions of milking, unclean milk handling equipment and the use of contaminated cleaning water were among the important sources of milk contamination. The milk is generally exposed to different contaminants when it transferred from one container to another, transported to consumers as well as retailers from the production site without cooling facilities, and with no proper milk containers. Creating opportunities for rural and urban cattle producers by providing training and experience sharing forum may encourage dairy cattle keepers to improve milk and milk products quality and quantity in the cities. The milk intended for direct consumption as well as the water used for udder washing and cleaning of milk and milk products handling equipment should be heat treated. Researches should be made in relation to the farm based assurance of milk and milk by products.

Keeping the quality of milk is not only the responsibility of dairy producers, but it should also concern government; non-governmental organizations and consumers in general should feel responsible. So far, there was no standard practice for method of handling dairy products in dairy farms.

Based on the above conclusion the following recommendations are made:

- Creation of awareness to dairy producers on adequate udder preparation, hygienic milking system, cleaning of milking equipments and pasteurization to promote hygienic quality of milk and shelf life
- The state regulatory agency shall set a hygienic standard based on the local condition and routinely control the quality of milk produced by such urban and peri urban producers
- Raw milk should be boiled using available materials at pasteurization time and temperature.
- Adequate sanitary measures should be taken at all stages from production to consumption to provide whole some sound dairy products to the needy society.
- Clean water should be available for better cleaning and sanitizing milk equipments
- Pasteurization of milk intended for consumption should be adapted by dairy societies
- Storage and transportation of milk should follow safety standards

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