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THE MICROBIOLOGICAL COMPOSITION OF MILK AND ASSOCIATED MILKING PRACTICES AMONGST SMALL-SCALE FARMERS IN THE INFORMAL SETTLEMENT OF MONYAKENG

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BLOEMFONTEIN
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DECLARATION OF INDEPENDENT WORK

I, **KATHIE ELIZABETH JANSEN**, do hereby declare that this research project submitted for the degree **MAGISTER TECHNOLOGIAE: ENVIRONMENTAL HEALTH**, is my own independent work that has not been submitted before to any institution by me or anyone else as part of any qualification.

.....

SIGNITURE OF STUDENT

28 October 2003.

DATE

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ABSTRACT

Milking practices have improved with the development of technology and have transformed both small and large-scale production methods, although some rural and peri-urban areas have not adopted these new methods for various reasons. Hand milking is therefore still one of the most frequently used methods, especially for families that own one to six head of cattle. Efficient milking techniques and impeccable hygiene standards are essential when milking is performed by hand.

The population that was studied is situated in Monyakeng, the black township of Wesselsbron in the Free State Province in South Africa. The aim of the study was to determine the nature and extent of milking practices of small-scale farmers in the Monyakeng Township and to determine the influence of such milking practices on the microbiological quality of the milk produced.

The objectives of the study were to determine the presence of contaminating organisms in the milk produced by the typical small-scale farmer, to assess the milking practices of the small-scale farmers, and to draw conclusions regarding possible relationships between milking practices and the microbiological composition of milk in order to make suggestions regarding the improvement of milk quality.

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The milk quality was assessed from both a microbial point of view and from an ethical perspective, and this assessment includes the milking practice and the health of the animals. The questionnaire survey provided a means of determining the level of understanding of the respondents in terms of milk handling, milking practice, animal health, structures utilised and respondents' knowledge with regard to personal and general hygiene.

Considering the total viable counts, coliforms and *E. coli,* it was apparent that undesirably high numbers were prevalent, exceeding the national standard by far. Results furthermore indicate that the counts of the coliforms and *E. coli* differ significantly from summer to winter. The high presence of *E. coli* found in milk samples points to the fact that although respondents are aware of the importance of avoiding faecal contamination of milk, this is not common practice. Unnoticed illnesses are likely to be one of the causes of the alarmingly high microbial counts found in the study. The respondents are, however, not accustomed to the clinical and sub-clinical signs of mastitis and they are reluctant to associate their cattle with any illness. The general hygiene knowledge of the respondents was good, as shown by the large numbers of respondents who covered the milk with a lid. This is obviously advisable, and the respondents were, without exception, aware that personal hygiene is important. 100% of the respondents also reasoned that if the cattle were ill the milk quality would be poor and the majority understood the meaning of the term hygiene. Traditional practices are also likely to contribute to

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contamination of milk and proliferation of micro-organisms. These include practices such as keeping the milk warm for as long as possible in winter and wiping the hands with the tail of the cow. Lack of proper herd management also contributes to very low yield, unhealthy cows and a generally undesirable milking infrastructure.

It was finally concluded that a definite relationship exists between milking practice and the microbiological composition of milk in the study area.

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OPSOMMING

Melkpraktyke het, tesame met die transformasie van beide klein en groot produksie praktyke, met die ontwikkeling van tegnologie verbeter, alhoewel sommige landelike en semi-landelike gebiede nog nie hierdie ontwikkelings om verskeie redes geïmplimenteer het nie. Hand metodes is daarom nog steeds een van die mees algemeen gebruikte metodes van melk onder gesinne wat van 1 tot 6 beeste besit. Effektiewe melkmetodes en hoë higiëne standaarde is belangrik wanneer hand-melking uitgevoer word.

Die populasie wat bestudeer is, is geleë in Monyakeng, die swart woonbuurt van Wesselsbron geleë in die Vrystaat Provinsie in Suid Afrika. Die doel van die studie was om die aard en omvang van melkpraktyke onder kleinskaal melkboere in die Monyakeng woonbuurt te ondersoek en die invloed van sulke praktyke op die mikrobiologiese kwaliteit van die melk te bepaal.

Die doelwitte van die studie was om die teenwoordigheid van kontaminerende organismes in melk wat geproduseer word deur tipiese kleinskaal melkboere en die gepaardgaande praktyke te ondersoek ten einde afleidings te maak rakende verwantskappe tussen bogenoemde aspekte. Hierdie poging het ten doel die daarstelling van voorstelle om die melkkwaliteit te verbeter. Die melkkwaliteit is ondersoek uit beide 'n mikrobiologiese sowel as 'n etiese perspektief, insluitend

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aspekte soos die gesondheid van die diere. The vraelys studie het 'n metode gebied waardeur die begrip van die respondente in terme van melkhantering, melkpraktyke, dieregesondheid, struktuurbenutting en respondent kennis getoets kon word.

In terme van die totale plaattellings, kolivorme en *E.coli* was dit duidelik dat onaanvaarbare hoë getalle teenwoordig was. Dit het die nasionale standaarde by verre oorskry. Die resultate dui voorts daarop dat tellings vir kolivorme en *E.coli* beduidend tussen winter en somer verskil. Die hoë teenwoordigheid van *E.coli* wat gevind is in melkmonsters dui daarop dat hoewel respondente bewus is van die belangrikheid om fekale besmetting van melk te vermy, dit nie algemene praktyk is nie. Onopgemerkte siektetestande is waarskynlik een van die oorsake van die kommerwekkende hoë mikrobe tellings wat in die studie gevind is. Respondente is op hoogte van die kliniese en sub-kliniese tekens van mastitis, hoewel hulle huiwerig is om hulle vee met enige siektetoestand te assosieër. Die algemene kennis aangaande higiëne was goed – 'n observasie wat bevestig is deur die feit dat hulle die melk met 'n deksel bedek. Hierdie praktyk is aan te beveel, asook die feit dat respondente sonder uitsondering bewus is dat higiëne belangrik is. 100% van die respondente het verder geredeneer dat indien beeste siek is, die melk kwaliteit dienooreenkomstig swak sal wees en die meerderheid het die betekenis van die term higiëne verstaan. Tradisionele praktyke is voor-die-hand-liggende bydraende faktore tot die kontaminasie van melk en die vermeerdering van mikro-organismes. Sulke praktyke sluit in die warm hou van melk vir so lank as moontlik en om hande

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met die stert van die koei af te droog. 'n Tekort aan behoorlike kudde-bestuur en 'n algemene swak melk infrastruktuur dra verder by tot 'n lae melk opbrengs en ongesonde koeie.

Die oorkoepelende afleiding wat uit die studie voortspruit is dat 'n definitiewe verwantskap bestaan tussen melkpraktyke en die mikrobiologiese samestelling van die melk in die studie-area.

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CHAPTER 1

INTRODUCTION

KE Jansen

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1. INTRODUCTION

1.1 HISTORICAL BACKDROP TO ENVIRONMENTAL HEALTH IN SOUTH AFRICA

Environmental health is a diverse science which plays an important role in the health and welfare of all cultures by taking into consideration all of humankind. The primary objective of environmental health is a healthy and safe environment for all. From this perspective, environmental health is neutral and within the environment of the "New South Africa" it caters not only for the more privileged in terms of the provision of safe food and excellent hygiene facilities, but also for the poor in the provision of basic health services and safe food vending practices. If neglect is determined it is the Environmental Health Practitioner's responsibility to facilitate the situation and to establish a better and safer environment for those concerned. In essence environmental health is the prevention of unhealthy practices, situations and circumstances that may cause harm to or may lead to illness in any human being who may be surrounded by, in contact with, or in the vicinity of any harmful element whether microbiological, physical or chemical. These harmful elements may be found in food, housing, water supply, industry and even in the working environment.

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Environmental health, better known in European communities as public health, is no new concept and in this field, in comparison with the European communities, South Africa has a rich heritage. In his article "Gesondheid en die mediese professie in die Oranje-Vrystaat, 1864-1871," Badenhorst (1992) indicates that health was a concern as far back as the mid-nineteenth century. In his summary this author mentions that the cultural heritage of the people of the Orange Free State was the result of their creativity. In this unique environment every innovative inhabitant was in a position to play his/her part in the development of the Free State's cultural history. Even the politicians played their part. In South Africa, racial segregation effectively meant that in terms of the 1910 Union Constitution, as well as the Land Act of 1913 and its subsequent amendment of 1936, 87% of the national territory of South Africa was allocated to whites, while the remaining 13% was reserved for blacks. Lupton & Murphy (1995) and Jeeves (2000) note that the government has been interested in medical services for blacks since the time of the Department of Public Health and Native Affairs, which dates back to the 1920s and the early 1930s. The new democratic approach has introduced an understanding of the urgent need to address the disastrous decline in the health status of migrant communities throughout the black rural areas.

The 30th World Health Assembly was held in 1977 and introduced the public health movement, which came to be known as "Health for All by the Year 2000".

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The key elements for primary health care included health education, promotion of food supply and proper nutrition, adequate safe water and sanitation, maternal and child health care, immunization against major infectious diseases, prevention and control of locally endemic diseases, treatment of common diseases and injuries and the provision of essential drugs. In developing countries, environmental health is largely associated with poverty, rapid and uncontrolled urbanization, agricultural and land use practices and rapid industrialization. South Africa has been experiencing massive urbanization since the repeal of the influx control laws. In and around towns, the growth of informal settlements may be observed, together with the proliferation of informal backyard structures particularly in the township areas (Von Schirnding, 1995).

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1.2 PERSPECTIVE OF THE SOUTH AFRICAN MILK TRADE

Africa has 14% of the world's cattle, 9% of the world's people and produces 2% of global milk. Average production levels of the 22 million animals classified as dairy cows are low, resulting in an availability of 26 kg of milk per person per annum. Dairy cow numbers have also increased, growing by 19% in the decade up to 1982 (Dodd & Phipps, 1995). In terms of agricultural production in general, milk production forms part of the R30 billion produced in South Africa from a wide array of activities during 1996 and shows a value of R2609.9 million gross value of agricultural production in 1995/6 production year (Agriculture in South Africa, [s.a]).

Milking practices have improved with technology development. Hand-milking is sufficient if one or two cows are kept for basic family needs. However, technological advances such as milking machines have transformed both small and large scale production methods. Production productivity increases and more milk can be produced in less time, with an improved quality (World Book Advisory Board, 1995; Coetzee, 2000). In South Africa, however, there is a large sector of the population that has no access to costly modern technology and hand-milking is still the only method used. There is no registration system for informal farmers and this hinders information transfer between the farmers and the local authorities. It is thus difficult to determine the hygiene or quality status

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of the milk and the economic impact cannot be assessed due to the fact that most of the farmers consume their own milk and seldom sell it. Milk is only sold to friends and family, who collect the milk from the informal farmer's home or in some cases, from the local spaza on the residential premises.

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1.3 THE EVOLUTION OF SOUTH AFRICAN LEGISLATION GOVERNING MILK HYGIENE AND PRODUCTION

The Union of South Africa was formed in 1910, although the British government and parliament reserved certain powers (Smith, 2002). Although mention was made of milk quality by staff assigned to the control of the Medical Officer of Health during 1902 in Johannesburg, Greathead (1991) reports that the first by-laws and regulations with regard to milk were promulgated from 1910 and even today, this is still an ongoing process. This implies that milk is definitely one of the most sought-after products and certainly one that is included in the daily diet of almost every South African. In the Area Handbook of the US Library of Congress (Coutsoukis, 1996) mention is made of Bantu-speaking farmers who kept large herds of cattle. These cattle were highly valued, as they constituted the material wealth of their owners. They were also valued for milk and hides, and were seldom slaughtered for meat except during ceremonial occasions.

In Article 14 of Chapter 1 of the Public Health Act, 1919 (Act 36 of 1919) provision was made for a health service as well as for the appointment of a sanitary inspector. The primary goal was to assist in the safeguarding of public health and compliance with the act in the districts. Article 113 of Chapter 7 specifies that "No person shall sell, or shall prepare, keep, transmit or expose for

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sale, any milk, dairy produce, meat or other article of food which is not clean, wholesome, sound and free from any disease or infection or contamination; and no person shall collect, prepare, manufacture, keep, transmit or expose for sale any such article without taking adequate measures to guard against or prevent any infection or contamination thereof." Article 115 (c) states that the act aimed at "fixing standards of cleanliness of milk and scribing the warning to be given to any cow-keeper, dairy man or purveyor of milk that any milk sold or kept or transmitted or exposed for sale by him has been found to be below any such standard, and the issue of orders prohibiting the sale or the keeping or exposure for sale of milk from any cow, or milk shop, the milk from which is found, after analysis and official warning, to be below any such standard". The term cow-keeper is defined as "any person who keeps any cow" (South Africa, 1919).

The above-mentioned Articles emphasise the important role played by the cow-keeper during that period. One of the shortcomings of our current Health Act (Act 63 of 1977) is that such people are not mentioned; this leaves a loophole in the system, as their role and the quality of the milk used and distributed by them cannot be monitored (South Africa[a], 1977). No data has been collected regarding these groups and this issue is seen more as a monitoring problem than a health-related problem. The Foodstuffs, Cosmetic and Disinfectant Act (Act 54 of 1972) and R1555 of 1997 refer to the term "person" and mention in Article 3 (1) "that no person shall after two years from the date of publication of these

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regulations sell any raw milk, raw cream, raw skimmed milk, raw reconstructed (prepared) milk, raw reconstructed (prepared) skimmed milk or raw milk that has become sour, except in the areas of jurisdiction the local authorities listed in Annexure C," which does not include the study area. There is no mention of milk that is produced by the owner of cows that are milked for personal use or families' use and thus no control or standards have been determined for this function. The lack of permanent residence also hampers the tracking of the herds as the majority of the cattle roam around the residential area and nearby grasslands. The owner of the cattle does not own these areas and no form of address is thus available for tracking purposes.

In the Monyakeng township, milk from the cows of informal farmers is one of the primary food products for the Monyakeng community and due to their cultural background they prefer raw milk to pasteurized milk. However, during the previous dispensation in South Africa the Monyakeng residents had been used to keeping their cattle in their own yards or making use of surrounding fields for grazing. When the amalgamation of these areas took place, the public health regulations (R236 of 1973) did not change and did not accommodate the interests of these cattle owners. The regulations forbade the keeping of any farm animals or poultry in residential areas (Chapter 3, Article 8). It therefore became a major problem for these communities to accommodate their cattle, whilst the quality of milk derived from these sources was seriously neglected.

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During the transition period in South Africa, legislators and law-enforcers were challenged by the appearance of "informal" or "illegal" milk on the market. These milk supplies were regarded as illegal since they often consisted of raw or unpasteurized milk from herds not certified free from bovine tuberculosis or Brucellosis and were in other ways not conforming to regulations. The regulations referred to here, were until recently those stipulated in Regulation 258 of 8 February 1985 in terms of section 15 (1) of the Foodstuffs, Cosmetics and Disinfectant Act, 1972 (Act 54 of 1972). While these regulations were basically sound, there were loopholes and the selling of informal milk from a variety of retail outlets caught local authorities on the wrong foot. This was especially the case in smaller towns and rural areas. The Department of Health published regulations relating to milk and dairy products on 21 November 1997 (R1555 of 1997) under the Foodstuffs, Cosmetics and Disinfectants Act. These regulations specify the microbial quality of raw milk for further processing and raw milk for consumption. In South Africa, the required quality of raw milk for consumption is the same as the standard for pasteurized milk. Ingredients and labelling standards (Article 9) were stipulated in Regulation 2034 of 1993.

The Health Act (Act 63 of 1977) only refers to a milking shed as an essential part of milking practice and standards when milk is produced to be sold to the public or any processing plant or manufacturer (South Africa[a], 1977). Regulation 1256 of 1986 (article 2 (2)) provides that the erection of a milking shed is not

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applicable when milk is produced solely for own use; therefore, the small-scale farmer is not bound to build such a structure. It is generally accepted that individuals who milk their cattle for own purposes do not have to comply with the above mentioned standards but should take cognisance of good milking practice, hygiene, milk handling and storage to produce a safe, sound and wholesome product.

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1.4 FACTORS INFLUENCING MILK QUALITY AND HYGIENE

Milk is one of the most common food sources in the human diet. It is also a product that is directly available for consumption and is easily spoiled by temperature changes because of microbial growth. (Frazier *et al.*, 1988) The term "milk" can be defined as follows: "*Milk shall mean the mammary secretion obtained from the mammary glands of healthy cows of the bovine species during the usual lactation period by means of complete and regular milking*" (Act 54 of 1972). Milk has distinct physical, chemical and biological characteristics. "The odour, taste, colour, consistency, specific gravity (1,032), freezing point (-0,55°C) and pH (6,6) are physical characteristics that remain particularly constant. Milk freshly obtained from a cow will always contain some bacteria and somatic cells, which constitute the biological constituents of milk" (Turner & Veary, 1990).

Fresh milk will always contain a certain number of micro-organisms and also presents a favourable environment for their multiplication (Gilmour & Rowe, 1981). Micro-organisms play an integral part in spoilage and unhealthy contamination of milk and milk products. In South Africa the extent of

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microbiological contamination of informal or deregulated dairy products is still unclear (Manhanta, 1984).

1.4.1 The producer and management

A continuous search for excellence is the ideal strategy for researching higher levels of quality and the dairyman must recognize the potential issues and know the interrelationship of milk production and milk quality. Dairy producers are faced with numerous safety issues relating to milk such as pathogenic organisms, mycotoxins, naturally-occurring allergens, chemical residue, drug residues and hormones (Pienaar, 1987; Barbano, 1992; Murphy, & Boor, 2000; Tybor & Gilson, 2002). A recent survey by the Animal Nutrition and Animal Products Institute, Irene, indicated the growing sector of smallholder dairy farmers in the peri-urban areas, especially in the Gauteng province. The survey pointed out the critical role of milk-recording for the development of a viable and sustainable smallholder dairy sector for South Africa (Banga, 2001). General management and hygiene practices of the smallholder farmer are just as important as a milk-recording scheme.

Milk quality starts with proper management. The animal's health status has a definite impact on the quality of milk. The bacterial population of freshly drawn milk from a healthy cow is largely derived from the environment within which the

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cow is kept, the equipment through which the milk passes and the container in which it is stored. There are numerous factors which could influence the quality as a whole, the most common being handling, temperature, storage and packaging. Management of the herd and milking shed produces a good bacterial result and Coetzee (2000) confirms that management is the most important aspect of the milking procedure. When management is competent, bacteriological counts as low as 5 000 to 6 000 bacteria per millilitre are achievable (Coetzee, 2000).

1.4.2 Hand-milking

Efficient milking techniques are essential, especially when milking is done by hand. McNitt (1993) mentions that in South Africa the average number of cows hand-milked per man-hour was five, while during the same period in Europe, the average number was eight per man-hour. He suggests that the methods of preparation and milking contribute to this discrepancy. Statistics from the major milk producing countries indicated an annual decline in the number and size of sheds where hand-milking is practised (World Health Organization, 1996). The labour productivity in such herds is low, with very few cows per person involved. The duration of milking each cow is long with a relatively slow milk extraction rate compared to machine-milking. This contributes to lower average lactation yields in hand-milked herds. Nevertheless, for small herds, hand-milking will

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usually be the method of choice, because maintenance and cleaning is minimal with little or no capital investment on equipment.

Good hygiene standards are required during milking. Clean milking cloths and hooded milking buckets are necessary to prevent dust, dirt and udder hairs from falling into the milk. The udders and tails of cows need regular clipping before milking begins. The foremilk should be drawn and examined and all visible dirt should be removed from the udder and teats through washing and drying off with disposable towels. Milking should commence with clean, dry hands, using the full hand in preference to just a finger and thumb, which could lead to misshapen udders and teat injuries. It is best to milk the rear quarters first as they contain the higher proportion of milk. Whether you are hand or machine milking, the cow should be adequately prepared for all the milk to be removed from the udder; the milk should then be cooled within 3 hours or transported to a cooling facility. Cleaning the milking bucket is best done by rinsing in clean water immediately after milking, followed by scrubbing in a hot detergent/disinfectant solution before finally rinsing with chlorinated water. The foremilk cup, stool and udder-washing equipment should be treated similarly. All equipment must be drained dry during the intervals between milkings (Bodman & Rice, [s.a]).

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In 1932, Davel and Neethling compared the bacteriological quality of hand-milking to that of machine-milking. Their results showed that higher total counts and lower *E. coli* counts were obtained from machine-milking compared to hand-milking, which indicated that the machine-milking technique is a safer process with regard to the possibility of faecal contamination although not necessarily the most effective in terms of total microbial counts (Davel & Neethling, 1932). In a national survey by the Department of Health (1995) the hygiene of fresh milk offered for sale to customers in South Africa demonstrated that only 25% of a total of 918 samples included in the survey complied with all the requirements of the regulations mentioned in R1555 of 1997 promulgated under Act 54 of 1972 for raw and pasteurized milk. Of the 36% that represented raw milk samples, only 4% complied (South Africa[b], 1997).

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1.5 MICROBIOLOGICAL CONTAMINATION OF MILK

In milk, micro-organisms are divided into two classes according to their ability to grow at certain temperatures, namely mesophilic (room temperature) and psychrotropic (temperatures ranging from 5–15°C) organisms. Micro-organisms will break down components of milk (protein, fat or sugar) resulting in metabolites, which are not normally found in fresh milk (Jonssons, 2001). Their growth rate also varies in accordance with their various strains. There are three stages of growth: in the first, or lag phase, growth is slow while the organism adapts itself to the growth medium. This is followed by a rapid growth phase, or the log phase, during which numbers increase considerably. The third phase, or the stationary phase, is characterised by a decrease in numbers because of over-growth and growth medium shortages (Bodman & Rice, 1993; Muir, 1996). Micro-organisms reproduce by binary fusion and the generation time for micro-organisms in milk can be as short as 30 minutes at a temperature above 25°C (Del Castillo, 1990).

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1.5.1 Milk-borne diseases

There have been numerous outbreaks of milk-borne disease in humans caused by pathogens such as *Staphylococcus aureus, Escherichia coli, Camphylobacter spp.* and *Salmonella spp,* especially since mass production came into effect

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(Bryan, 1983). Most of these outbreaks have been attributable to insufficient pasteurization or post-pasteurization contamination.

During February and March 1994, an outbreak of *E. coli O104:H21* infection was identified through stool culture or serological evidence in the Helena area in Montana, USA. One brand of milk was associated with the illness. After investigation of the dairy plant, it was found that the coliform count exceeded the state regulation in at least one ready-for-sale milk product. No *E. coli O104:H21* were identified on equipment, in any dairy product or in the cattle from the production farms. Shigella-like toxin-producing *E. coli* is a well-recognized cause of gastro-intestinal illness, causing both bloody and non-bloody diarrhoea (United States Food and Drug Administration, 1995).

Micro-organisms present in milk may also be the cause of serious zoonotic diseases. In this case, the disease is transmitted from animals to humans and is common in developing countries where hygiene is still sub-standard (Foster, 1990). General infections often transmitted in milk include typhoid fever, diphtheria, scarlet fever and mastitis-related entero-toxaemia, while the most severe zoonoses transmitted via milk are tuberculosis and brucellosis (Van der Westhuizen, 1998).

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1.5.2 Causative agents of mastitis

Bovine mastitis is not a single disease but an inflammation of the mammary glands of cattle with various possible causes. Most cases of mastitis are caused by *Staphylococcus aureus, Streptococcus agalactiae, Escherichia coli* and other bacteria. Each of these diseases has a different epidemiology and pathology. Mastitis infections can be chronic or acute, and some respond quickly to the cow's natural defence mechanisms. In some cases, infections remain undetected for a very long time. The effect of infection is the destruction of some or all of the mammary tissue of the infected gland which results in a reduction in yield and the quality of the milk produced. If mastitis is treated effectively there is no major damage to the structure of the udder and it recovers naturally during the dry period. Untreated or chronic mastitis could, however, cause tissue damage. Most forms of clinical mastitis respond positively to antibiotic therapy, although some infections caused by staphylococci may not be eliminated completely (Blowey, 1988; Dodd & Phipps, 1995; Blowey & Edmondson, 2000).

Cows with mastitis and cows which have been treated with antibiotics should be milked last, or milked with separate milking units equipped with backflush to avoid the spread of infection via contaminated teat-cup liners. Segregation of *S. aureus* infected cows has been proven to significantly reduce the prevalence of related mastitis in cows as well as bulk tank somatic cell counts in milk (Jones,

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1998). Usually mastitis from coliform bacteria are not spread from one cow to another. The coliform organism invades the udder through the teat channel when a cow comes in contact with unsanitary environments between milkings. Coliforms multiply rapidly in the mammary gland. They produce endotoxins which are released when the micro-organism is destroyed by the defence mechanism (leukocytes) of the body. The toxins are absorbed into the blood stream and the cow will present signs of fever, lack of appetite, weight loss, abnormal milk and decreased production (Kirk, 1993; Hillerton, 1996).

In a study in the Netherlands, involving seven herds with bulk tank somatic cell counts of less than 150,000, 610 cows were cultured every 5-6 weeks, then again at dry off and calving, and again when clinical mastitis developed (Jones, 1998). The environmental pathogens comprised 46% of total infections and most showed signs of environmental mastitis (94% of *E. coli* and 64% of environmental streptococci). Environmental pathogens are often responsible for clinical cases of mastitis although only a few of the cases become chronic (Jones, 1998; Bowley & Edmondson, 2000). In developing countries mastitis is one of the most difficult infections to control.

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1.5.3 *E. coli* and *Enterobacteriaceae*

Members of the *Enterobacteriaceae* Family are Gram-negative, small, motile rods. Their optimum growth temperature tends to be higher (>30°C) than that of *Pseudomonas spp.*, but they adapt well to refrigeration temperatures. The usual source of *Enterobacteriaceae* in raw milk is from the digestive tract of the cow via faecal contamination of the bedding or the udder. Some strains of *E. coli* produce toxins and although most only constitute a moderate hazard as a source of food poisoning, the Enterohaemorrhagic *E. coli 0157:H7* causes particularly fatal illnesses in children (Pharasi, 1998).

A number of pathogens grow readily at refrigeration temperatures. *E. coli* is such an organism and is fairly often found in raw milk. Although *E. coli*, *Yersinia enterocolitica* and *Listeria monocytogenes* grow at low temperatures, they are killed by heat treatment (Holt *et al.*, 1994; Muir, 1996; Bell & Kyriakides, 1998). Apart from raw milk, examples of food implicated in outbreaks of *E. coli 0157:H7* include hamburgers, fresh-pressed apple cider, yoghurt, cheese, dried cured salami, and cooked maize (Molena, 1994; World Health Organization, 1996). Milk and milk products have however been incriminated in outbreaks in the United States, Netherlands (1997) and Canadian Northwest Territories (1991) as a result of the isolation of faecal samples from animals on farms and in the

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manure, which is strongly associated with faecal contamination (Willshaw *et al.*, 1993; Orr, 1994; Heuvelink *et al.,* 1998; Ruegg, 1999; Bastain & Silvera, 2000).

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1.6 OUTLINING THE STUDY AREA

1.6.1 Cultural setting and demographics

Urbanization of the Black population has led to dramatic changes in eating patterns and living conditions. Lack of infrastructure such as inadequate roads, shops and electricity is regarded as a major problem concerning food safety in certain rural areas in South Africa (South African Milk Quality Forum, 1997). One of the basic foodstuffs consumed by black South Africans is milk. They prefer raw milk and, as pointed out by Walton (1956), the cattle kraal is one of the most distinct cultural aspects of the South Sotho people. "The traditional South Sotho kraal is also grouped around the cattle fold with its attached calf kraal, but today, with the decline of polygamy, village clusters of unrelated families are normal and the layout of such villages is determined largely by physical conditions with a consequent lack of formal arrangement" (Walton, 1956). Families are forced to live on sites designated by municipal officers as residential premises and do not always have the privilege of being able to choose a site near other family members.

The population that was studied is situated in Monyakeng, the black township of Wesselsbron, which is situated about 55 kilometres from the city of Welkom (Welkom is situated at the centre of the Goldfields), in the northern part of the Free State province of South Africa (Figure 1).

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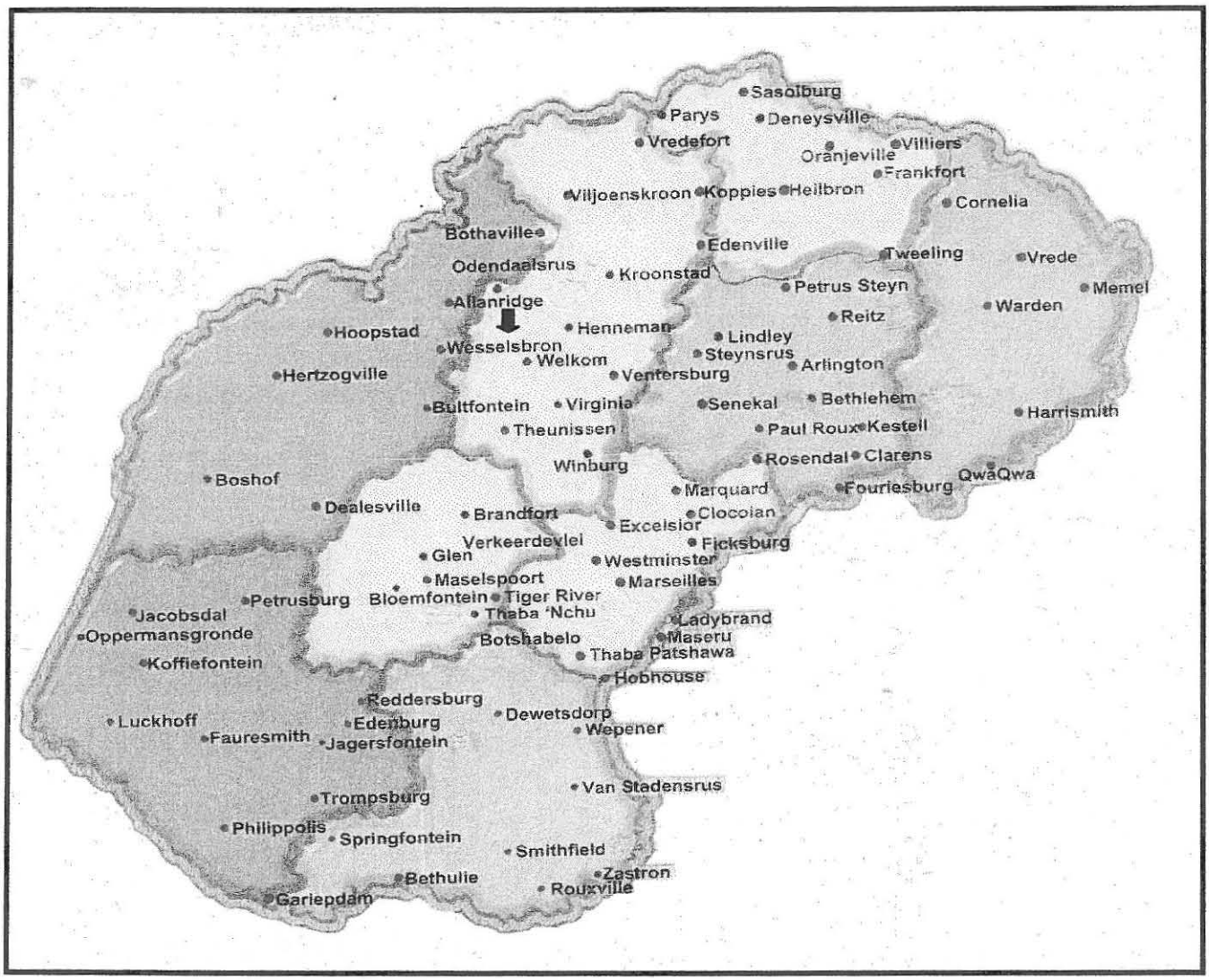

Figure 1. A map indicating the research area (Monyakeng, Wesselsbron) (Department of Health, 2002).

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Monyakeng's socio-economic structures vary from formal to informal structures. Although there are a few flush toilets connected to septic tanks within the community, the greater part of the population make use of the bucket system, and in some areas latrine facilities are non-existent. Every stand has its own water supply, except where new structures are erected. The main power sources are electricity, wood and paraffin, and candles/gaslight may be used as a source of light. Some houses do however make use of more than one of the previously mentioned methods. The community has four schools, a police station, municipal offices and a primary health care clinic within one kilometre of the nearest residence.

Cattle kraals are mostly situated at the four corners of the residential area (Figure 2) with a minimum number of cattle in the residential area at the owners' homes. The cattle are housed in medium-sized kraals at night. Most of the kraals are built from wooden and/or steel poles with wire fencing attached to the poles. Each kraal has a swing or concertina gate, made of the same materials (Figure 2). Most of the kraals are joined, and open into a gathering kraal where all the cattle are gathered before they go out for grazing. Grazing takes place on municipal land or any vacant area surrounding the residential area of Monyakeng. One person is responsible for supervision of the cattle and is paid an amount by each small-scale farmer per month for his/her duties.

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Figure 2 (A-D). Kraal structures (A-D), and the gathering kraal where the cattle are gathered before they are released for grazing.

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1.6.2 Milking technique and practice

Figure 3 illustrates the strip-milking technique which is used by the respondents and is one of three hand-milking techniques (McNitt, 1983). The teat is held between the thumb and the first (index) finger. It is pulled downwards along the teat. A lubrication medium such as Vaseline (Elida Pond's (Pty) Ltd.) is used to facilitate milking. Milking takes place during the early morning hours, usually between 4:00 and 8:00, and some cows are milked a second time in the late afternoon between 16:00 and 19:00. Hand-milking takes place at the kraal and milk is collected in buckets. It is then transported by foot or by vehicle to their homes.

Although the provision of buildings requires considerable capital input, it has been shown to be very important for the well-being of both the dairy herd and the staff looking after the herd (Food and Agriculture Organization of the United Nations; 1989). Obviously economic aspects are extremely important and consideration must be given to the cost of providing accommodation (Slater, 1991). It is clear that the average informal small-scale farmer does not have these facilities, nor does he have the basic equipment for proper milking. Because dairy products are consumed directly as food, proper sanitation in the preparation, storage, handling and distribution of these commodities for human consumption is of the utmost importance.

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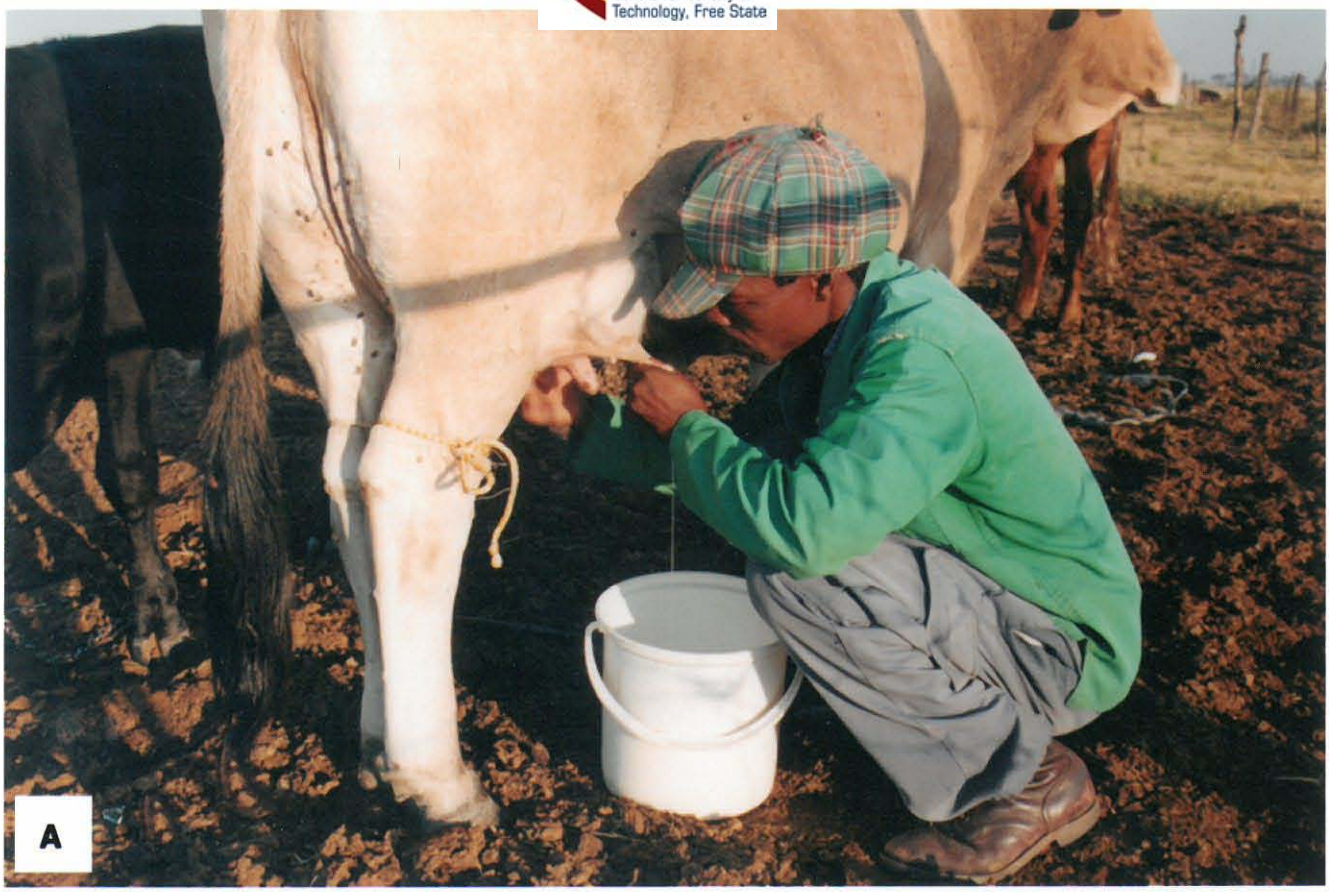

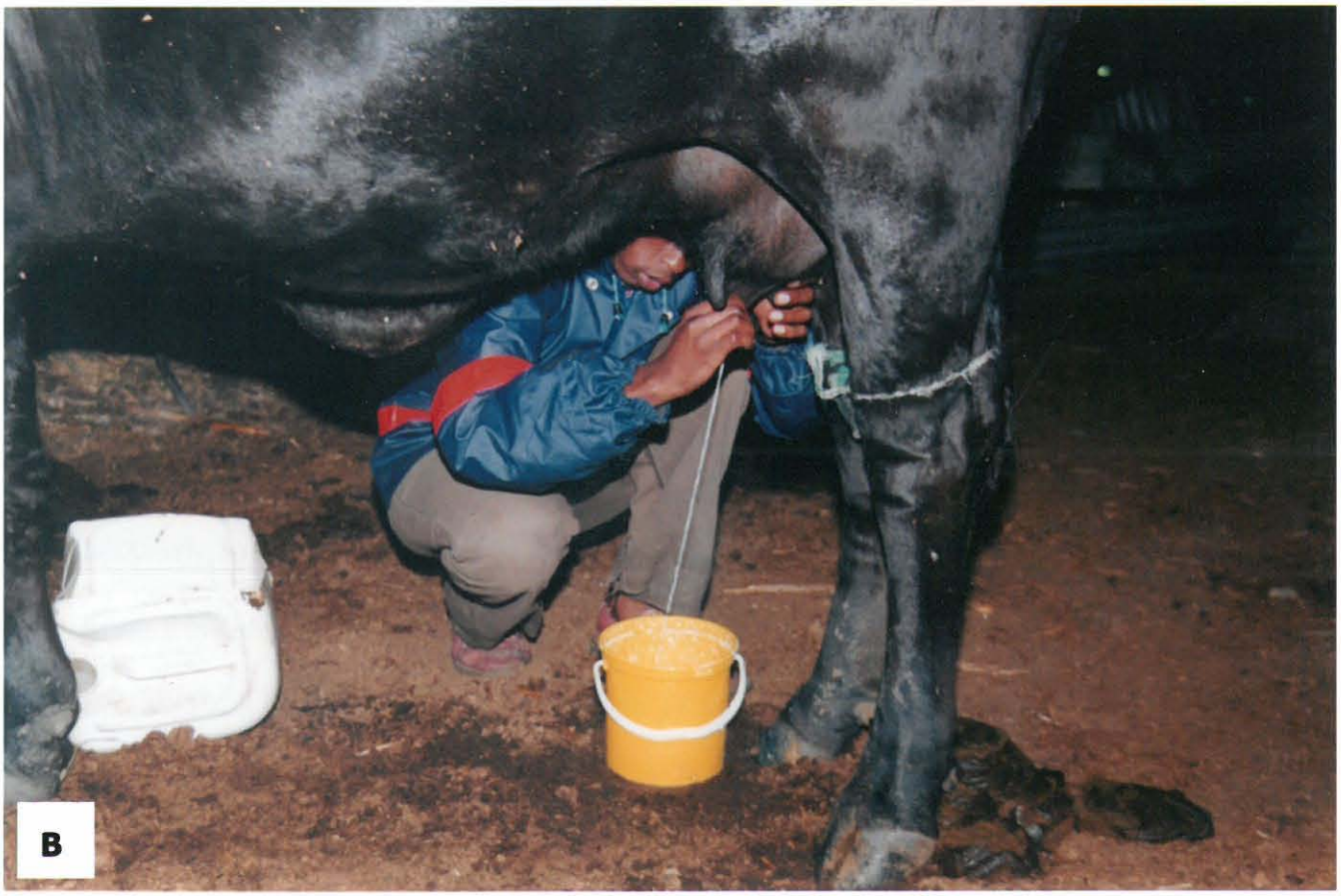

Figure 3 (A-B). The strip-milking technique is utilized by the milkers in the research area.

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1.7 RATIONALE

1.7.1 Stating the problem

The extent of the microbiological contamination of milk produced by the small-scale farmer in the informal settlement of Monyakeng is unknown, and the milking practices of the small-scale farmer are not clear. Futhermore, an obvious lack of knowledge of basic milking hygiene and the risks involved as a result of contaminated milk are major causes of poor quality milk and undesirable microbiological composition.

1.7.2 Aims and objectives

The aim of the study is to determine the nature and extent of milking practices of small-scale farmers in the Monyakeng Township and to determine the influence of such milking practice on the microbiological quality of milk.

The objectives of the study are firstly to determine the presence of contaminating organisms in the milk produced by the small-scale farmer, secondly to assess the milking practices of the small-scale farmers, and thirdly to draw conclusions regarding possible relationships between milking practices and the microbiological composition of milk so as to make suggestions on improving the milk quality.

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CHAPTER 2

MATERIALS AND METHODS

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2. MATERIALS AND METHODS

This study comprised both an experimental study and a descriptive survey. Firstly a microbiological assessment was done followed by a questionnaire survey. A comparative discussion brought these two aspects together.

2.1 MICROBIOLOGICAL STUDY

2.1.1 Sampling protocol

Two information sessions were held with the small-scale farmers of Monyakeng: one to introduce the proposed research, and another to introduce the researcher to the community. A list was consequently drawn up with the names and addresses of all the farmers who farm with cattle and who produce their own milk. Fifty-seven farmers were identified of which 89.5% participated in the study. Figure 4 shows the small-scale farmers who attended the first information session.

Sampling was performed during the period January to July 2001 and fifteen consecutive sampling runs were conducted. Samples were collected every second Tuesday, from the residential premises of each small-scale farmer, kept

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Figure 4. The small-scale farmers who attended the first information session.

Figure 5. The helpers who participated in the data collection.

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on ice to restrict microbial multiplication and transported to the laboratory for immediate analysis.

2.1.2 Appointing and training of assistants

Three community volunteers were trained to collect the samples from each household and an additional assistant was utilized as translator as well as to perform community liaison functions (Figure 5). The latter individual was responsible for all meetings and also assisted in translating questions and presentations. The workers were trained through demonstrations to carry out aseptic sampling. The importance of aseptic sampling was clearly conveyed to them, as well as the influence that a non-aseptic sampling could have on the outcome. They were also trained in the completion of the questionnaires.

A map was obtained of the research area (Monyakeng Township), and the participating small-scale farmers divided into four sections. Each community volunteer was allocated a section for which he/she was responsible for the duration of the study. Each helper was issued with a white laboratory coat, a sponsored hat for identification purposes and a map, which detailed the sampling route for a specific worker. All participating farmers were visited, regardless of whether their cows were in production during the sampling run.

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2.1.3 Microbiological analysis

The Plate Loop Method was used to quantify the various microbial groups (Houghtby, 1993). Standard Plate Count Agar (PCA, MERK) was used in accordance with the specifications of R1555 of 1997 (Annexure A, Article 7) to enumerate total aerobic colonies in milk (Houghtby *et al.*, 1993; South Africa[b], 1997). For the enumeration of total coliforms and *E. coli*, Violet Red Bile - Mug agar was used in accordance with the specifications of R1555 of 1977 (Annexure A, article 5) (South Africa, 1972; Chirsten *et al.* 1993). All plates were incubated at 32°C for 48 hours.

Evaluation of results was carried out in accordance with standards set in Articles 2 and 4 of R1555 of 1997 stating that standard plate counts may not exceed 50 000 cfu.1ml^{-1} (raw milk intended for consumption) and 200 000 cfu.1ml^{-1} (raw milk for further processing)(Table 1). The mentioned legislation further states that, for both the purpose of direct consumption and further processing, coliforms must be below 20 cfu.1ml^{-1} and *E. coli* absent in 1 ml of milk (direct consumption) and absent in 0.01ml (further processing)(South Africa[b], 1977). Currently, no standard is set for milk where it is generated for personal use. Thus the above standards governing milk quality for the purpose of selling (R1555 of 1977) were utilized to evaluate the milk in this study (Table 1).

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Table 1. A summary of the South African standards for raw milk (R1555 of 21 November 1997) promulgated under the Foodstuffs, Cosmetics and Disinfectants Act (54 of 1972).

	Total counts ($cfu.ml^{-1}$)	Total coliforms ($cfu.ml^{-1}$)	*E. coli*
Raw milk intended for direct consumption	≤50 000	≤20	0 in 1,0 ml
Raw milk intended for further processing	≤200 000	≤20	0 in 0,01 ml

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All analyses were performed at least in duplicate and the significance level for statistical analysis was $P \leq 0.05$.

2.1.4 Recording of environmental temperatures

All environmental information was collected from the South African Weather Services in Pretoria and updates were received throughout the sampling period. Sample temperatures were taken at the point of sampling by means of a sterile mercury thermometer.

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2.2 QUESTIONNAIRE SURVEY

2.2.1 Design and evaluation

The questionnaires used in the descriptive study were compiled in English and translated into South Sotho. Information was gathered pertaining to the demographic background, infrastructure, condition of cattle, milking techniques, hygiene knowledge and practice of the respondents (Annexure A (English), and B (South Sotho)).

Three volunteers were responsible for distributing questionnaires in the area. The respondents (n=57) were allocated randomly to the volunteers, with 18 respondents per volunteer. Interviews were carried out at each of the respondents' houses, with the milkers themselves. A total of 54 questionnaires were completed (96.4% response rate). Care was taken to inform the respondents that their participation was voluntary and anonymous. The community volunteers were fluent in both English and South Sotho.

2.2.2 Coding and interpretation

The questionnaires were encoded after the completion of all questionnaires and a coding table was developed into which the respective codes were captured.

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Calculations of percentages and drawing of graphs were done by the computer program Microsoft Excel.

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CHAPTER 3

RESULTS

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3. RESULTS

3.1 SECTION A: MICROBIOLOGICAL INVESTIGATION

3.1.1 Enumeration of micro-organisms

The microbiological investigation was done to assess the contamination of milk and to establish contamination levels for evaluation against the data captured through the questionnaires in terms of the milking practices, as well as to draw conclusions regarding possible relationships between milking practice and microbiological contamination. In general the microbiological quality of the milk samples collected during the sampling period of 29 weeks from the small-scale farmers in the informal settlement of Monyakeng did not comply with the microbiological standards stipulated in the regulations.

Figure 6 (A-C) shows the distribution of the viable counts, coliforms and *E. coli* counts per millilitre in the milk. The distribution of the total viable micro-organisms (A) ranged from 10^4 to 10^7 cfu.ml^{-1}; none complied with the legislative standard of 50 000 cfu.ml^{-1} and only 6.1% complied with the 200 000 cfu.ml^{-1} guideline. The highest recorded count was 6,08 X 10^7 cfu.ml^{-1} and the lowest 1 X 10^4 cfu.ml^{-1}. The high counts suggested likely contamination via the external environment (dust and soil), the exterior of the udder, the presence of infection

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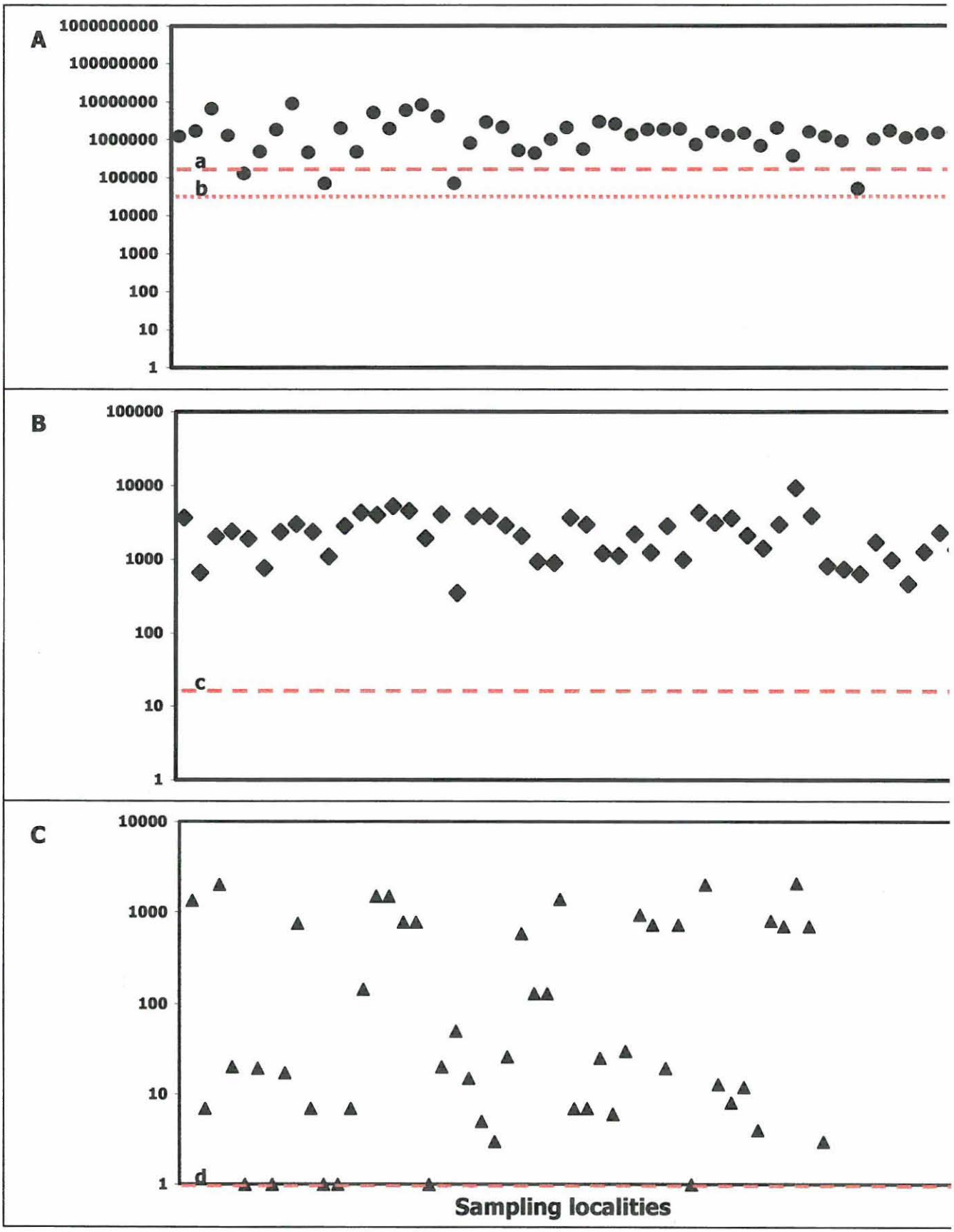

Figure 6 (A-C). Distribution of the (A) total viable micro-organisms, (B) coliforms and (C) *E. coli* in milk from the small-scale farmers of Monyakeng (Refer to table 1 for standard specifications indicated in red).

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within the udder (mastitis) and from the milk due to poor storage practices (Murphy, 1997; Department of Health, 1999; Jones, 1999; Blowey & Edmondson, 2000; Murphy and Boor, 2000). Lower counts obtained in some localities on the other hand, indicated that with improved hygiene and milking practices the milkers could obtain more acceptable counts even with the limited resources at their disposal. The results could also be indicative of poor general hygiene during milking as well as poor personal hygiene status of the milker (Department of Health, 1999).

The distribution of the coliform organisms mostly presented itself between 10^2 and 10^4 cfu.ml^{-1} (Figure 6 (B)). Wessels *et al.* (1988) suggest that this distribution could be expected because raw milk is usually contaminated with coliform organisms which are directly related to faecal contamination and the hygiene practices of the milker. The minimum and maximum counts obtained varied considerably with 1.7 X 10^4 cfu.ml^{-1} the highest. A lowest count of 10 was also recorded showing that the ideal could be achieved.

The *E. coli* counts are shown in Figure 6 (C) and was distributed between 0 – 10^4 cfu.ml^{-1}. The presence of *E. coli* in milk is highly undesirable and poses a considerable threat of food-borne disease (World Health Organization, 1997) associated with this type of contamination. *E. coli* is an organism associated with the presence of pathogenic micro-organisms and is prohibited in all milk and milk

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products (South Africa[c], 1977). Luck & Gavron (1987) report that the presence of *E. coli* can be associated with faecal contamination during milking; the high coliform distribution noted in Figure 6 (B) thus indicates that a considerable degree of faecal contamination occurred. Alarmingly high *E. coli* counts were observed, of which the maximum was 8.3×10^3 cfu.ml^{-1} whilst only 12.2% of the milk samples conformed to legislation (absent in 1 ml).

The results found in this study corresponded with a survey done by the Department of Health: Food Control (1999) showing total plate counts in raw milk in excess of 2×10^5 cfu.ml^{-1}, coliforms above 110 cfu.ml^{-1}, and in 51,3% of the samples *E. coli* was detected. The report furthermore suggests that these high levels could be an indication of poor general hygiene of milking environments as well as poor personal hygiene of the milkers.

3.1.2 Conformance to national legislation

The distribution and growth of micro-organisms in milk samples from the small-scale farmers compared to the national guidelines is indicated in Figure 6 (A-C). The national standard for total viable counts with regard to raw milk for consumption is 5×10^4 cfu.ml^{-1}. None of the milk samples complied to this standard (Figure 6 (A)). An average count of 1.8×10^5 cfu.ml^{-1} was furthermore found, which is much higher than the standard for raw milk intended for

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consumption, although within the limits set for raw milk intended for further processing. In fact, a total of 6.1% of samples did comply with milk destined for further processing. The fact that none of the milk complied with the 5×10^4 cfu.ml^{-1} standard indicates that drastic measures would have to be implemented in order to achieve conformity. Murphy and Boor (2000) report that a cow with mastitis has the potential to shed large numbers of micro-organisms (up to 10^7) into the milk supply. The influence of mastitis on the total bacteria count of milk depends on the strains of the infecting micro-organism(s), the stage of infection, and the percentage of the herd infected. Keeping this in mind it could be suggested that infections in the udder together with unhygienic practices could be responsible for these marked high counts. Davel and Neethling (1932) mention that hand-milked milk generally has higher total counts, ranging between 10^4 to 10^5 and it could therefore be concluded that the milking practice also contributes to the microbiological outcome of milk as far as the total viable plate counts are concerned.

Figure 6 (B) shows the distribution of the coliform organisms averaging 1.9×10^3 cfu.ml^{-1} over the sampling period of 29 weeks. This is relatively high when compared with the national standard of 20 cfu.ml^{-1} (South Africa^c, 1997). None of the samples conformed to this standard, presenting a definite cause for concern. The coliform count contributes significantly to the bacterial count of milk and is predominantly associated with the environment as well as with

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manure. Coliforms usually indicate contamination and poor hygiene practices although in some instances strains occur naturally in the environment. These organisms may enter the milk from soiled animals or from equipment having been dropped on the floor or in the soil. Boor *et al.* (1998) and Murphy and Boor (2000) explain that where counts of more than 50 cfu.ml^{-1} coliforms prevail, it can be regarded as an indication of poor milking hygiene, insufficient washing practices and resulting dirty equipment, or related environmental mastitis. Coliform bacteria are also associated with taste and texture failure in dairy products (Wessels *et al.*, 1988).

National standards stipulate unambiguously that no *E. coli* is allowed in raw milk (South Africa[c], 1977). Figure 6(C) shows the alarmingly high presence of *E. coli* in milk sampled from the small-scale farmers in Monyakeng. It is however apparent that considerable fluctuations occurred during the sampling period. The average value for *E. coli* organisms was 1.6 X 10^1 cfu.ml^{-1} throughout the sampling period of 29 weeks. Only 12.2% of all the samples complied with the set standard of none per ml. Apart from resorting under the coliform group and exhibiting many of the group's ecological and contamination characteristics, *E. coli* organisms are more directly associated with faecal contamination. Furthermore, apart from its obvious pathogenicity, *E. coli* can also be associated with gas formation in milk and could cause defects such as taste problems (turnpike flavour) (Frazier, 1988).

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3.1.3 The influence of temperature

Figure 7 shows the patterns of environmental temperature, the milk temperature and the average distribution of the total viable organisms, coliform organisms and *E. coli* organisms at the time of sampling. All microbial counts decreased during the later stages of sampling except for the total viable micro-organism count, which remained between 1 X 10^6 and 1 X10^7 cfu.ml^{-1}. Throughout the sampling period the coliform counts decreased by approximately 1 log phase whereas the *E. coli* counts decreased from ± 10^2 to almost undetectable quantities. The drop in the counts of these organisms is concomitant with a drop in sample (24°C to 18°C) and environmental (29°C to 5°C) temperatures. According to the data portrayed in Figure 7, it could therefore be concluded that the temperature of the milk samples and environment had a definite affect on the growth of the bacteria.

Coliform and *E. coli* growth is considerably affected by temperature, and micro-organisms can theoretically grow at all temperatures between freezing point and the temperature at which protein or protoplasm coagulates. One of the most influential factors of microbial growth is temperature, and each micro-organism has an optimum temperature where it multiplies best (O' Connor, 1994). Du Preez and Kowalski (1987) suggest that the keeping quality of milk is adversely affected by the microbial count if it exceeds 2 X10^5 and that the temperature of

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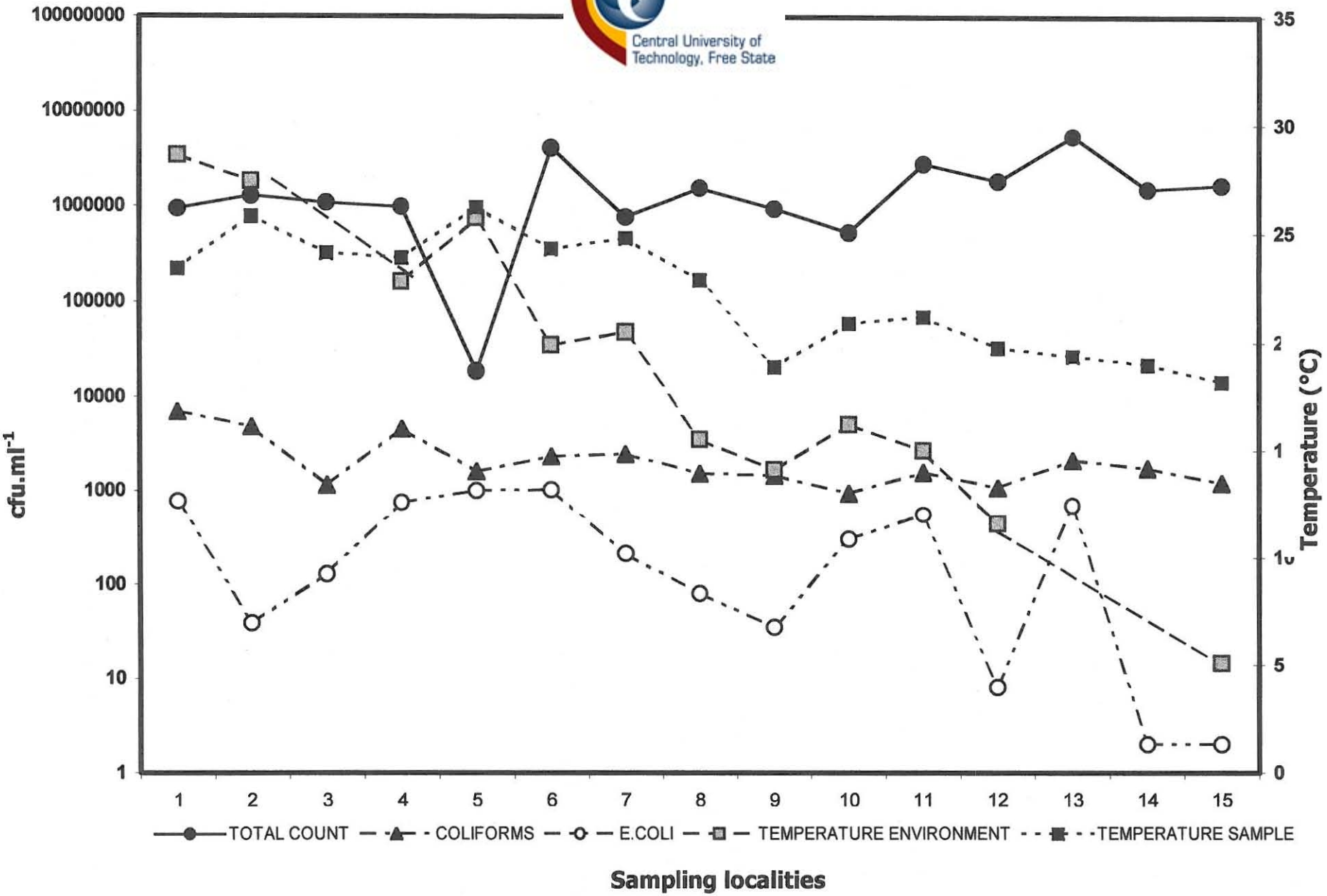

Figure 7. Microbial and temperature changes during the sampling period

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milk should not exceed 5.5°C. Milk should be chilled within 30 minutes after milking, from 35°C to 4°C, on order to slow down bacterial growth. Kessler and Horak (1984) also indicate that the keeping quality is unsatisfactory in under-pasteurized milk and that the most satisfactory results can only be established at 5°C after heat treatment of between 71°C - 78°C.

Swart *et al.* (1988) found an average psychrophilic count in South African mass-contained raw milk *circa* 2 X 10^4 cfu.ml^{-1}. The average shelf-life of milk with this count is 105 hours at 4°C, 82 hours at 6°C and 57 hours at 8°C, illustrating the radical effect that temperature has on shelf-life and microbiological predominance. Hankin *et al.* (1977) positively correlate the number of storage days and the storage temperature with the number of bacteria present in milk.

3.1.4 Inter-relationships between micro-organisms and temperature

In order to determine the exact statistical relationships between the sample and environmental temperatures, as well as amongst the various microbiota, Spearman's correlation was used to construct a correlation matrix using the following 5 variables: total viable counts, coliforms, *E. coli*, sample temperature and environmental temperature. The purpose of this evaluation was to ascertain the actual role that temperature plays during informal milking processes, as well

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as to establish whether the microbial groups (total viable counts, coliforms and *E. coli*) stipulated in legislation as indicators, in fact present an accurate measure of the true microbial load.

In Table 2 the correlation matrix of the mentioned variables is shown over the whole sampling period. A weak positive correlation (r^2=0.34) was noted between the coliforms and *E. coli*, indicating some resemblance between these two indicator groups. Notable was the observation that the total viable counts did not correlate significantly with neither coliforms nor *E. coli*. This emphasizes the fact that this group should be included as a parameter for the evaluation of microbial contamination and cannot necessarily be deduced merely by measuring the coliforms and *E.coli*. The most likely reason for this observation is that the total counts (also known as aerobic plate counts (APC) or mesophilic plate counts (MPC)) comprise many different microbial genera, which exhibit a diverse range of growth conditions and temperature preferences.

Over the entire sampling period, the environmental temperatures correlated moderately (r^2=0.56) to strongly (r^2=0.75) with the *E. coli* and coliforms respectively. There was also a strong correlation between the sample and environmental temperatures, proving that the milkers have little or no means available to protect their milk against environmental temperature fluctuations. The fact that no or weak correlation existed between the sampling temperature

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Table 2. Correlations (r^2) amongst the various organisms, sample and environmental temperatures in milk collected from the informal settlement of Monyakeng over a period of 29 weeks.

	Total viable count	Coliform	*E. coli*	Sample temperature	Environmental temperature
Total viable count					
Coliform	-0.1050				
E. coli	0.2895	0.3409			
Sample temperature	-0.1288	0.4323	0.4380		
Environmental temperature	-0.2731	0.7549	0.5615	0.8661	

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and the microbial growth, suggests that the source of contamination was not necessarily from proliferation in the milk itself, but rather from other external sources such as hides, dust, faecal material or the milker, that are not influenced by the temperature of the sample. Furthermore, according to the results it may be suggested that allowing the sample temperature to more closely resemble the environmental temperature in winter, could be a means of curbing the contamination from, and the predominance of, bacteria, especially of faecal origin. i.e. coliforms and *E. coli*. It was noted, for example, that during winter the milkers attempt to keep the milk warm for as long as possible after milking.

Figure 8 (A-B) represents the total viable count, coliforms and *E. coli* during the summer and winter months of the sampling period compared to the legislative standards. The environmental temperatures during summer and winter varied considerably and the microbial values supported the contention that milk will have a lower microbial count during the winter because of lower environmental temperatures. Figure 8 indicates that there is a negligible deviation with regard to the total viable counts during the winter and summer months while the coliforms and *E. coli* are considerably lower in winter. A significant difference did not occur between the total viable counts in summer and winter (Table 3). The winter coliform counts, however, differed significantly between summer and winter and a significant difference also occurred between the summer and winter *E. coli* organism counts.

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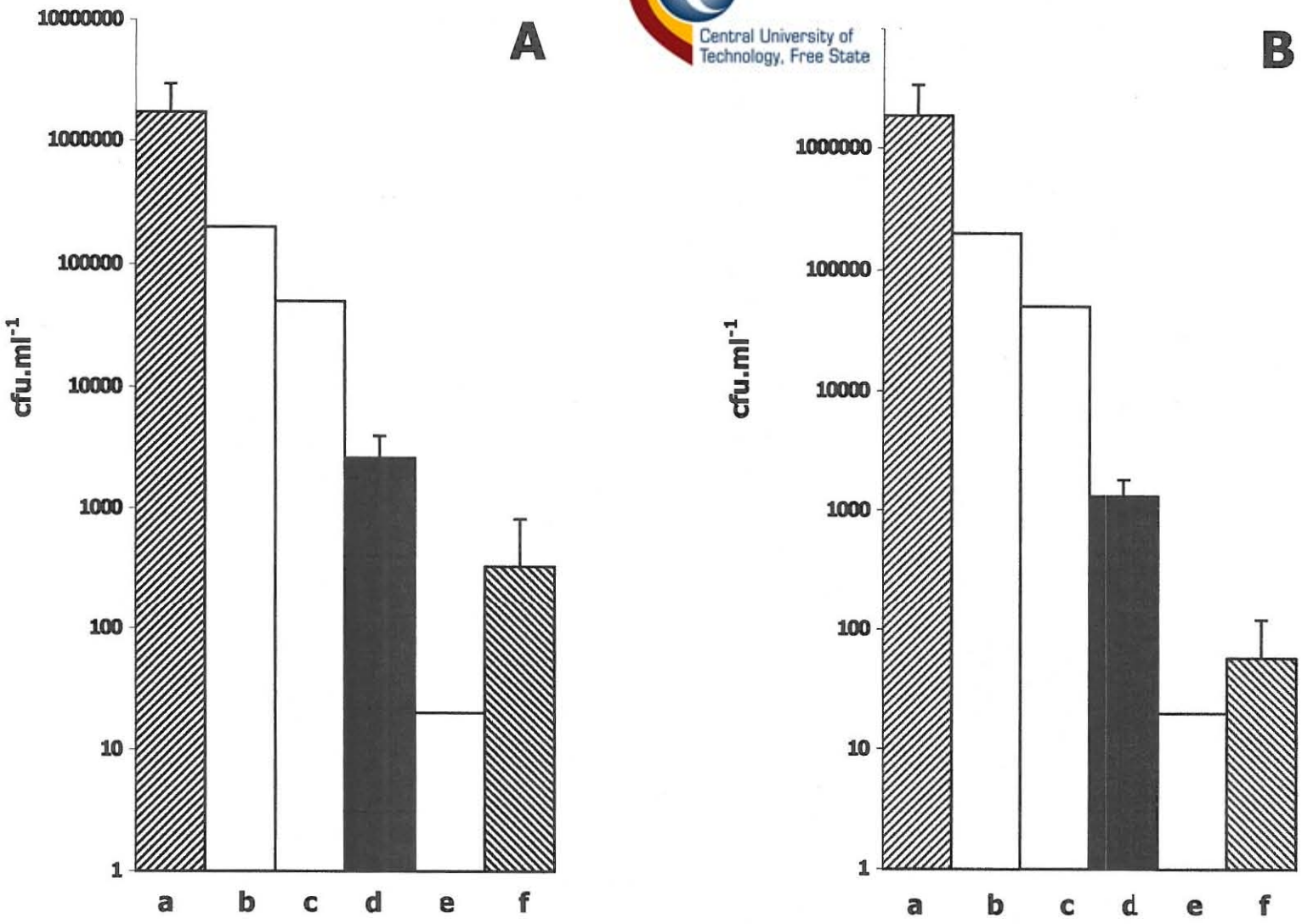

Figure 8 (A-B). The summer microbiological results (A) and winter microbiological results (B) evaluated against the legislative standards and demonstrating the deviation of each micro-organism. a: Total viable micro-organisms; b: Legislative standard for total viable micro-organisms (raw milk for further processing); c: Legislative standard for total viable micro-organisms (raw milk for consumption); d: Coliform micro-organisms; e: Legislative standard for coliform organisms (raw milk for both consumption and further processing); f: *E. coli* micro-organisms (Legislative standard for *E. Coli* organisms in raw milk intended for further processing is absent in 0,01ml and for direct consumption, absent in 1 ml).

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Table 3. Significant differences amongst the micro-organism counts in winter and summer (P≤0.05).

	WINTER		
	Total viable count	**Coliform**	***E. coli***
SUMMER			
Total viable count	Insignificant (P≥0.05)	-	-
Coliform	-	Significant (P≤0.05)	-
E. coli	-		Significant (P≤0.05)

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3.2 SECTION B: QUESTIONNAIRE SURVEY

A questionnaire survey was performed to gather information pertaining to the demographic background, infrastructure, milking techniques and hygiene knowledge and practices of milkers as well as additional aspects such as the condition of cattle.

3.2.1 Demographic information of respondents

Table 4 summarizes the information that served as a background to the residential profiles of the households evaluated in the study. The households were smaller than expected with the majority of families having 2-3 children and 2-3 adults per household (any person older than 19 years of age was regarded an adult).

The infrastructure and way of life of this community was related to their habits and the accessibility of resources such as water, which often precluded their implementation of proper milking practices (Matthewman, 1993). Table 4 further indicates that 39.6% of respondents sell milk to other families, which is a high percentage when considering that there is no or little control over these supplies. 69.8% of all small-scale farmers were milking once a day and 30.2% twice a day

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Table 4. Demographic, infra-structure and cattle information of the informal settlement of Monyakeng.

Demographic						
	0	**1**	**2-3**	**3-5**	**5-7**	**More than 7**
Number of children in household	7.5	3.8	39.6	24.5	20.8	3.8
	0	**1**	**2**	**3-4**	**More than 4**	
Number of adults in household	1.9	11.3	41.5	30.1	15.1	
Cattle owned and milked						
	1	**2**	**3-4**	**5-6**	**More**	
How many cattle do you own (n=52) [a]	1.9	21.2	30.8	9.6	36.5	
How many cows are currently milked (n=52)	44.2	32.7	15.4	1.9	5.8	
Infra-structure						
Do you sell milk to other families	**YES**	**NO**				
	39.6	60.4				
How many times a day do you milk your cattle	**ONCE**	**TWICE**	**THREE TIMES**	**MORE**		
	69.8	30.2	0	0		
	AT HOME	**IN THE FIELD**	**ON AN ENCLOSED AREA IN THE FIELD**	**UNDER A SPECIFIC TREE**	**AT A SELF-CONSTRUCTED MILKSHED**	**AT A NEARBY REGISTERED MILKSHED**	**OTHER**
Where do you milk your cattle	7.5	13.2	62.3	0	15.1	1.9	0

[a] Frequency (n) value only indicated in cases where the full amount of respondents did not answer the question

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(Table 4). Steenkamp (1999) notes that milk production increases by 20% when milking three times a day compared to only twice a day.

At the time of data collection 36.5% of the respondents owned more than 6 animals while 44.2% and 32.7% indicated that they owned one or two. The average number of cattle owned by the small-scale farmers in Monyakeng was 6 cattle per household with an estimated total of 342 animals (data not shown). During the milking process it became obvious that milkers only milk the required amount of milk needed by the families and often cows are not milked to full capacity. The milkers use the calves to suckle from their mothers to stimulate lactation and directly commenced with hand milking without washing the teat and udder. This practice has obvious hygiene implications.

The average quantity of milk retrieved by milkers in the study area (from 1 - 5 litres per day) is much lower than would be expected from typical healthy cows in full lactation (*circa* 136,2 litres per household taking the average number of 6 cows per respondent into account as well as the fact that a healthy cow should produce ± 22,7 litres of milk per day)(Hallowell, 2002). This low milk production in relation to the number of cows milked is likely to be the result of milkers not milking the animals to full capacity. Cows are poorly managed in terms of lactation periods, are often kept as a valued asset and not as a milk producer, poor and improper milking management, ineffective milking practices and

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ineffective or deficient cattle care. Lack of domestic infrastructure such as running water, electricity and refrigerators undoubtedly contribute to the predicament of the milkers in terms of milk production and preservation.

62% of small-scale farmers milk in an enclosed area in the field (Table 4), whereas 15.1% milk in a self-constructed milk shed, 13.2% in the open field and 7.5% at home. In Figure 2 (A-D) (Chapter 1) it was mentioned that no physical structures exist other than the kraal structure of wire, wood and steel poles. None of the kraal structures had a cement floor and thus the milking area could not be properly cleaned or sanitized. Hammer and Babel (1957) conclude that the contamination from external sources is considerably reduced when the cows and floor are cleaned, the manure removed on a daily basis, utensils sterilized and the udders and teats of the cow washed. The authors thus suggest that the milking environment has a marked effect on the quality of milk produced.

3.2.2 Condition of cattle

The health conditions and treatment of cattle are presented in Table 5. This aspect is of primary importance because the health of the cattle has a direct effect on the quality of milk produced (Hillerton, 1996; Bowely & Edmondson, 2000; Tybor & Gilson, 2002). 86.8% of respondents indicated that none of their cattle had ever been treated by a veterinarian surgeon, whilst 78.8 % of the

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Table 5. Condition of cattle

Infra-structure						
	YES	**NO**				
Has a veterinarian or technicianever treated your cattle	13.2	86.8				
[a] Have your cattle been ill recently (n=53)	21.2	78.8				
	CAUGHING	**DIARRHOEA**	**SCARS/BLEEDING/ SWELLING OR ANY VISABLE ILLNESS OF THE UDDER**	**LOSS OF APPETITE**	**PROSTRATION**	**OTHER**
[b] If "Yes" what symptoms did theanimal show (n=9)	0	11.1	0	55.6	22.2	11.1
	DO NOT TREAT THEM AT ALL	**I TREAT THEM MYSELF**	**GO TO SENWES FOR MEDICATION AND ADVICE**	**TAKE THEM TO THE LOCAL VETERINARIAN**	**OTHER**	
If your cattle are ill, where you take them? (n=37)	0	29.7	46	24.3	0	

[a] Frequency (n) value only indicated in cases where the full amount of respondents did not answer the question

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respondents indicated that their cattle had recently been ill. 55.6% of the respondents indicated that a loss of appetite was the most apparent sign of illness (Table 5). Loss of appetite is one of the most common indicators of poor health and the presence of illness. McNitt (1983) and Kirk (1990) point out that apart from loss of appetite, a further common sign of mastitis infection is an elevated body temperature and depression. It is further suggested that all milk-producing cows should be routinely examined for the presence of disease. Results in Table 5 further shows that a notable percentage (46%) of respondents consulted Senwes for medication and advice whilst the remainder of respondents treated the cattle either themselves (29.7%) or took the cattle to a local veterinarian (24.3%). The importance of animal health is of primary concern when one considers the number of animals owned by the small-scale farmers, keeping in mind that some of the illnesses could be contagious and could affect the entire animal population as well as the quality of milk derived from these animals.

3.2.3 Milking techniques

In Table 6 the milking techniques that were used during milking practice are described. 47.1% of the respondents indicated that their helpers were restricted to not more than two people. The father was found to be primarily responsible for milking whereas in 24,5% of the cases it was one of the sons. This aspect is

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Table 6. Milking techniques.

	YES	NO						
Do you start milking directly after the cow has given birth	32	68						
	YES	**NO**	**SOMETIMES**					
When you milk a cow do you chain the back legs together	81.1	18.9	0					
Do you wash the udder of the cow before you start to milk	86.8	13.2	0					
Does soil from the udder or faecal material/urine enter the milk when you are milking (n=51)	17	74.5	7.9					
Do you continue milking a cow that has mastitis (n=44)	9.1	90.9	0					
Do you milk a mastitis cow separately (n=36)	80	20	0					
Do you milk a cow that appears ill (n=52)	3.8	96.2	0					
	ONLY YOU	**ONE**	**I HAVE ONE HELPER**	**I HAVE MANY HELPERS**				
How many people milk your cows	47.1	11.3	20.8	0				
	FATHER	**MOTHER**	**GRAND-FATHER**	**GRAND-MOTHER**	**ONE OF THE SONS**	**ONE OF THE DAUGHTERS**	**A FRIEND OR NEIGHBOUR**	**OTHER**
Who is responsible for milking the cows	35.8	1.9	0	0	24.5	0	3.8	1.9

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important because the more handlers there are, the more difficult it becomes to educate milkers and to control the milking practice applied. Table 6 furthermore indicates that 81.1% of the respondents tied the back legs of the cow together during milking. 86.8% of the respondents indicated that they wash the udder of the cow before they start milking. 74.5% indicated that no dirt from the udder, faecal material or urine enters the milk while they are milking, 17% indicated that dirt does enter the milk and 7.9% indicated that it sometimes enters the milk during milking (Table 6). This suggests that the respondents are aware that contamination from external sources can occur, but due to neglect or limited vision during the early morning hours when milking takes place, it is accepted as normal practice.

According to Table 6, 32% of the respondents start milking the cow directly after it has given birth. This practice is highly undesirable, as the natural bacterial count in milk after giving birth is much higher than normal. The cow should be separated from those being milked for a period of fourteen days prior to calving and five days thereafter. The colostrum is very rich in vitamins and minerals and has a naturally higher somatic cell and bacterial count (Frandson, 1986). 96.2% of respondents indicated that they do not milk a cow that appears ill, while 90.9% indicated that they do not continue milking a cow that has mastitis. When questioned as to whether the cattle were milked separately when they suffer from mastitis, 80% of the respondents indicated that they do separate them.

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	YES	NO
Do you visit the toilet before milking your cattle	9.4	90.6
Do you know what the term "hygiene" means.	60.4	39.6
[a]Do you pour the milk from the milking bucket into another container for the household	94.3	5.7

	PLASTIC OR GLASS BOTTLE WITH LID	PLASTIC OF GLASS BOTTLE WITHOUT LID	PLASTIC OF GLASS BUCKET WITH LID	PLASTIC OR GLASS BUCKET W.O. LID	OTHER
[b]If yes, into what do you pour it (n=55)	15.7	0	82.3	2	0

	YES	NO	SOMETIMES
Do you milk the cattle yourself when you are ill (n=54)	5.7	94.3	0
Do you pour the fresh milk with the previous day's left-over milk	1.9	98.1	0
Is personal and general hygiene important when you are milking the cow	100	0	0
Do you think there are germs in milk (n=55)	64.7	31.4	3.9
Do you think you can become ill from milk	52.8	45.3	1.9
Do you think the milk will be bad when your cattle are ill	100	0	0

	YES	NO	SOMETIMES	NEVER
Do you cover the container when you are carrying the milk home	96.2	1.9	0	1.9

	AFTER MILKING	BEFORE MILKING	DURING MILKING	BEFORE AND AFTER	NOT EVERY DAY	NEVER
When do you wash your hands	0	37.7	1.9	54.7	1.9	0

	IN THE TREE NEAR THE HOUSE	IN A FRIDGE	IN OR ON TOP OF A KITCHEN CUPBOARD	NEAR A STOVE	ON THE FLOOR	OTHER
Where do you keep your milk during summer	9.4	69.8	11.4	0	9.4	0
Where do you keep your milk during winter	3.8	47.2	37.7	0	9.4	0

	DIRECTLY	AFTER 5-10 MIN.	AFTER 15-30 MIN.	BEFORE 10 AM.	AFTER 10 AM.	AFTER 1 PM.	AT NIGHT	OTHER
How long after you have milked, do you consume the milk for the first time.	20	4	10	18	34	12	2	0
How long after you have milked, do you consume the last of the milk (n=53)	0	0	4.1	4.1	6.1	51	20.4	14.3

	IT HAS BECOME SOUR	IT HAS BECOME THICK	IT CONTAINS CLOTS	THERE ARE VISIBLE SIGNS OF DIRT/FOREIGN OBJECTS IN MILK	THERE ARE VISIBLE SIGNS OF FERMENTATION OR MOULD GROWTH IN OR ON THE MILK	THERE IS BLOOD IN THE MILK	OTHER
Do you sometimes consume milk that appears as follows	38.6	36.4	0	0	0	0	0

[a] and [b] are related questions.

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This practice is ideal and care should be taken, by thorough hand-washing, that bacteria are not transmitted to healthy cows.

3.2.4 Hygiene knowledge and practices

Table 7 outlines the level of hygiene knowledge and related milking practice of the small-scale farmers in Monyakeng. In terms of personal hygiene, 90.6% of the survey indicated that respondents do not visit a toilet facility prior to milking their cattle. Most respondents (54.7%) indicated that they wash their hands before and after milking.

Where milk is carried to the household, 96.2% of the respondents indicated that they cover the container in which the milk is transported. 94.3% stated that they pour their milk from the milking bucket into another container to be used in the household. This practice increases the handling of the milk product and the hygiene of the second container could contribute to microbial contamination. Of the 94.3% respondents who transfer their milk from the milking bucket to another container, 82.3% used a plastic or glass bucket with a lid, 15.7% a plastic or a glass bottle and 2% a plastic or glass bucket without a lid for storage.

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From Table 7 it was evident that 98.1% of the respondents do not add milk to the previous day's milk. The time period between milking and consumption is relatively short and the survey indicated that most of the first milk was consumed shortly after 10:00. 20% of respondents indicated that they consumed the milk directly upon arrival at home. The remaining milk is consumed after 13:00 (51%) and during the evenings (20.4%). Many of the respondents consume milk that has become sour (38.6%) and thick (36.4%). None of the respondents indicated that they consume milk that contains clots, visible signs of dirt/foreign objects, notable signs of fermentation or contamination in or on the milk, or signs of blood.

The respondents indicated that during the summer 69.8% keep their milk in a refrigerator while 11.4% indicated that they keep it at room temperature in the kitchen. 9.4% of the respondents indicated that they keep their milk on the floor or in a nearby tree during the summer months to keep cool. In winter, 47.2% prefer to keep their milk in a fridge, 37.7% in or on top of a kitchen cupboard, 9.4% on the floor and 3.8% in a tree near the house (Table 7).

The respondents' knowledge of hygiene was surprisingly high. The entire population knew that personal and general hygiene is important whereas 60.4% of the respondents knew the meaning of the term "hygiene" and 100% reasoned that if the cattle were ill the milk would be of poor quality. 64.7% of those

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taking part in the survey were of the opinion that bacteria are present in milk. A total of 52.8% of the respondents indicated that one could become ill from milk whilst 45.3% indicated that one could not become ill from milk.

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3.3 CONCLUDING REMARKS

In terms of the microbiological data derived from this study it was clear that the milk produced by the small-scale farmers in Monyakeng does not conform to national legislation in terms of raw milk intended for direct consumption. This phenomenon has been supported by various authors cited in this study for milk from more formal environments, and does thus not truly represent a measure of the quality of the milk in comparison with more formal sources such as commercial plants. However, a more alarming cause for concern is the high levels of *E. coli* organisms in the milk, indicating the presence of possible pathogens. Results furthermore showed that the counts of coliforms and *E. coli* in particular, differed between winter and summer, being significantly lower in winter. Inter-relationships amongst the microbiota analyzed, furthermore indicated that the various organisms are not necessarily inter-dependent and should thus not be used as indicators for the presence of each other. The questionnaire survey highlighted a number of malpractices and negligence of the milkers towards optimal and safe milk production. These include aspects such as under-utilization, and the prevalence of disease amongst cows. It was evident that, although respondents had a degree of knowledge regarding hygiene practices, these were not applied in practice. Milkers often persisted with practices that were preferred because of traditional beliefs, but had obvious

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health consequences. One such practice includes attempting to keep the milk warm for as long as possible (especially in winter) while cooling down would in fact benefit the microbiological composition.

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CHAPTER 4

DISCUSSION AN CONCLUSION

KE Jansen

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4. DISCUSSION AND CONCLUSION

Environmental health is a diverse science which plays an important role in the health and welfare of people of all cultures. It attempts to ensure a safe environment not only for the more privileged but also for the poor, through the provision of basic health services and hygiene practices. Due to the racial segregation policies of the past the black communities have suffered much in terms of environmental health. One of the cultural traditions that remained, however, was the keeping of animals near their houses or homesteads. These animals were kept as a sign of wealth or as subsistence farming for the family to provide in their daily needs for meat and milk. Milk is one of the primary food products of the Monyakeng community, and raw milk is preferred to pasteurized milk.

When the amalgamation of these areas took place, the health regulations (R236 of 1973) did not change and the owners of these cattle were not taken into consideration. Regulations prohibited the keeping of any farm animal in the residential area. It became a major problem in such communities to accommodate their cattle, and the quality of milk derived from these sources was seriously neglected. It was thus the purpose of this study to investigate the extent of microbial spoilage of milk in a typical township community

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(Monyakeng), as well as to assess the milking practices employed by the milkers in the area.

In terms of the total viable counts, coliforms and *E. coli,* it was apparent that undesirably high numbers were prevalent. None of the total viable micro-organism counts, none of the coliform counts and 12.2 % of the *E. coli* counts complied with the national evaluation standard for raw milk for consumption (50 000 cfu.ml^{-1}). When evaluated against the 200 000 cfu.ml^{-1} (raw milk intended for further processing) only 6.1% of the total viable counts complied. Results clearly indicated that the counts of coliforms and *E. coli* were significantly higher in summer than in winter.

The alarmingly high incidence of micro-organisms in the milk sampled in this study is of particular interest to the field of Environmental Health as well as to the community which utilizes this source as a primary element of their daily diet. The fact that throughout the sampling period most of the respondents' milk supplies did not comply with set legislative standards is not only a legislative concern but a direct concern with regard to the health status of the animals. The suitability of the product for human consumption is therefore also questioned.

The milk quality was not only assessed from a microbial point of view but also from an ethical perspective and this assessment included the milking practice

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and the health of the animals. The questionnaire survey provided a means of determining the level of understanding of the respondents in terms of milk handling, milking practice, animal health, structures utilized and respondents' knowledge with regard to personal and general hygiene. All the questions were formulated in such a way as to gather information to provide the researcher with a guide to be able to determine where the contamination of the product might originate. Due to non-specific isolation of bacteria, the identification of most pathogens was not included in this study and it could only be assumed that unnoticed illnesses could be one of the causes of the extremely high counts.

The respondents were familiar with the clinical and sub-clinical signs of mastitis but they were reluctant to associate their cattle with any illness. Figure 9 (A-B) shows a photograph of sores and infection in the herds, which confirms suspicions that there are undetected illnesses and infections present in the herds. Because the majority of respondents indicated that a veterinarian surgeon had never treated these cattle, it may furthermore be an indication that the high bacterial counts could be attributed in part to unnoticed illnesses. Although the questionnaire data demonstrated that the respondents had a high level of knowledge regarding hygiene, the coliform count, which is an indicator of hygiene practice and presence of faecal matter, proved the opposite. The incidence of coliforms and *E. coli* in raw milk presents a cause for concern due to their association with contamination by faecal matter and pathogens and also

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Figure 9 (A-B). Animals with signs of illness or infection belonging to the small-scale farmers in the informal settlement of Monyakeng.

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partly because of the spoilage that can be produced by their growth in milk at ambient temperatures. Coliforms can build up rapidly in moist conditions and relatively low coliform counts in milk do not necessarily point to clean and sanitary equipment. Authorities generally consider coliforms in excess of 100 $cfu.ml^{-1}$ as evidence of unsatisfactory production.

The period between milking and consumption of milk was found to be relatively short. This is ideal and the multiplication of microbial growth is thus prevented by lack of growth time. The practice of milking a cow directly after it has given birth would also have a direct influence on the bacterial counts of the milk. It furthermore appeared that the respondents were not aware of the clinical and sub-clinical signs of mastitis and that they were reluctant to associate their cattle with illnesses.

It is known that the respondents prefer the milk warm during winter months (and thus fail to see the need for refrigeration during this period) and cold in the summer months. Although the majority of respondents reported that they keep their milk in a refrigerator during the summer season while about half prefer to keep it in a refrigerator during winter, this does not agree with the actual infrastructure available in the households (in reality, only ±30% of households own a refrigerator). It is thus likely that the respondents gave the answers that

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they thought were expected of them, especially in cases that directly touched on their socio-economic status.

The general hygiene knowledge of the respondents was notable, as shown by the large numbers of respondents who covered the milk with a lid. This practice is obviously advisable, and the respondents were, without exception, aware that personal hygiene is important. 100% of the respondents reasoned that if the cattle were ill the milk quality would be poor and the majority understood the meaning of the term hygiene. The high presence of *E. coli* found in milk samples, however, points to the fact that even though they are aware of the importance of washing their hands, this is not commonly done. Apart from the ointment Vaseline (Elida Ponds (Pty) Ltd.), the majority of milkers do not take water or soap for hand cleansing with them.

The lack of proper management of the herd and milking infrastructure appears to be a major contributor to the ineffectiveness of milking and poor hygiene of the milk. For example, the amount of milk retrieved by milkers is much lower than the optimal amount of milk that could be retrieved from 6 cows (the average per household in the area). The dairy animals are kept in primary kraal structures, which do not protect them from environmental conditions, and water is not abundant. The respondents had to travel at least one kilometer to attend to milking and the likelihood that their hands would be recontaminated should be

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kept in mind. Figure 10 shows a milker who wiped his hands with the tail of a cow in the absence of water and soap for proper hand-washing. This practice is totally unacceptable and is likely to contribute to the microbial contamination (especially coliforms) of the milk and even to the likelihood of the cow to develop mastitis. Animal hides are well known sources of coliform, other faecal-related as well as spore-forming bacteria. The majority of respondents did, however indicate that they cover the container in which the milk is transported.

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Figure 10. A respondent uses a tail of the cow to wipe his hands.

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4.1 RECOMMENDATIONS

It is recommended that:

- the local town council be approached to erect a crush-pen for animal inspection and medical treatment;
- the milkers themselves be educated on correct care and basic animal welfare for their animals and on what is expected from a milk handler with regard to milking practice and milk quality;
- education sessions be formulated to include all aspects considered in the questionnaire;
- sponsorships be sought with regard to products such as mastitis test kits, in order to improve the knowledge and practice of the milkers.
- the local municipal health official/health inspector obtain a register for maintaining control over the milkers as well as to ensure a healthy product, although due to lack of manpower this would be an ideal situation;
- all municipalities be encouraged to obtain information regarding these small-scale farmers and to compile registers for these farmers who produce milk, regardless whether or not it is only for their own personal use; and

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- the placement of cattle in a central area or areas outside residential areas be undertaken by each local council to establish control over roaming animals, registered milking cattle and hand-milkers/informal small-scale farmers.

It should furthermore be kept in mind that the aim is not to abolish the practice or to eradicate the keeping of cattle by small-scale farmers but to educate the communities and handlers in order to obtain a good, wholesome and safe product for human consumption under controlled conditions.

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4.2 FUTURE RESEARCH

It is recommended that a study be undertaken to isolate the most prominent pathogens found in milk associated with informal settlements. It is possible to trace a wide array of animal illnesses in milk and research in this regard should be undertaken in co-ordination with the regional veterinarian technologist. Annual inoculations and other treatments necessary for good animal health could possibly be introduced in the area.

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ANNEXURE A

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Milking practices in the informal settlement of Monyakeng.

QUESTIONNAIRE

Please mark the correct / chosen answer with an "X".

(ALL INFORMATION IN THIS QUESTIONNAIRE IS CONFIDENTIAL).

1. DEMOGRAPHIC INFORMATION.

NAME: _____
RESPONDENT NUMBER: _____
INTERVIEWER: _____
RESPONDENT'S BIRTH DATE: _____
AGE: _____
ADDRESS (RESIDENTIAL):

_____

_____

_____

_____

TEL.: (H)_____
(W)_____

1.1 Number of children in household?

a) None			1
b) 1			2
c) 2-3			3
d) 3-5			4
e) 5-7			5
f) If more than 7, please specify_____			6

1.2 Number of adults in household?

a) None			6
b) 1			7
c) 2			8
d) 3-4			9
e) If more than 4, please specify_____			10

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2. INFRASTRUCTURE

2.1 Do you sell milk to other families?

a) Yes
b) No

		11
		12

2.2 How many times a day do you milk your cattle?

a) Once
b) Twice
c) Three times
d) More than 3 times

		13
		14
		15
		16

2.3 Where do you milk your cattle?

a) At home.
b) In the field.
c) On an enclosed area ("kraal") in the field.
d) Under a specific tree.
e) At a self-constructed milkshed.
f) At a nearby registered milkshed.
g) If other, please specify_____

		17
		18
		19
		20
		21
		22
		23

3. CONDITION OF CATTLE

3.1 How many cattle do you own?

a) 1
b) 2
c) 3-4
d) 5-6
e) If more than 6, please specify_____

		24
		25
		26
		27
		28

3.2 How many cows are currently milked?

a) 1
b) 2
c) 3-4
d) 5-6
e) If more than 6, please specify_____

		29
		30
		31
		32
		33

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3.3 Have your cattle been ill recently?

a) Yes | | | 34
b) No | | | 35

3.4 If "Yes" what symptoms did the animal show?

a) Coughing (Illness of the lungs) | | | 36
b) Diarrhoea (Illness of the stomach) | | | 37
c) Scars/bleeding/swelling or any visible illness of the udder (Mastitis) | | | 38
d) Loss of appetite | | | 39
e) Prostration (remains lying down/not able to stand up) | | | 40
f) If other, please specify_____ | | | 41

3.5 If your cattle are ill, where do you take them?

a) Do not treat them at all. | | | 42
b) I treat them myself. | | | 43
c) Go to SENWES for medication and advice. | | | 44
d) Take them to the local Veterinarian. | | | 45
e) Other, please specify_____ | | | 46

3.6 Has a veterinarian or technician ever treated your cattle?

a) Yes | | | 47
b) No | | | 48

4. MILKING TECHNIQUES

4.1 Who is responsible for milking the cows (if more than one please indicate all)?

a) The Father | | | 49
b) The Mother | | | 50
c) The Grandfather | | | 51
d) The Grandmother | | | 52
e) One of the sons | | | 53
f) One of the daughters | | | 54
g) A friend or neighbour | | | 55
h) If other, please specify_____ | | | 56

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4.2 How many people milk your cows?

a) Only you		57
b) One		58
c) I have one helper		59
d) I have many helpers		60

4.3 Do you start milking directly after the cow has given birth?

a) Yes		61
b) No		62

4.4 When you milk a cow do you chain the back legs together?

a) Yes		63
b) No		64
c) Sometimes		65

4.5 Do you wash the udder of the cow before you start to milk?

a) Yes		66
b) No		67
c) Sometimes		68

4.6 Does soil from the udder or faecal material/urine enter the milk when you are milking?

a) Yes		69
b) No		70
c) Sometimes		71

4.7 Do you continue milking a cow that has mastitis (visible udder infection, dry udder quarters, sores/cuts or bruises on the udder, sensitive teats)?

a) Yes		72
b) No		73
c) Sometimes		74

4.8 Do you milk a mastitis cow separately?

a) Yes		75
b) No		76
c) Sometimes		77

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4.9 Do you milk a cow that appears ill?

a) Yes		78
b) No		79
c) Sometimes		80

5. HYGIENE KNOWLEDGE AND PRACTISE.

5.1 Do you milk the cattle yourself when you are ill?

a) Yes		81
b) No		82
c) Sometimes		83

5.2 Do you visit the toilet before milking your cattle?

a) Yes		84
b) No		85

5.3 When do you wash your hands?

a) After milking.		86
b) Before milking.		87
c) During milking.		88
d) Before and after milking.		89
e) Not every day.		90
f) Never.		91

5.4 Do you pour the fresh milk with the previous day's left-over milk?

a) Yes		92
b) No		93
c) Sometimes		94

5.5 Do you pour the milk over from the milking bucket to another container for the household?

a) Yes		95
b) No		96

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5.6 If yes, where do you pour it into?

a)	Plastic or glass bottle with lid		97
b)	Plastic or glass bottle without lid		98
c)	Plastic or glass bucket with lid		99
d)	Plastic or glass bucket without lid		100
e)	If other, please specify_____		101

5.7 Do you cover the container when you are carrying the milk home?

a)	Yes		102
b)	No		103
c)	Sometimes		104
d)	Never		105

5.8 Where do you keep your milk during summer time?

a)	In the tree near the house		106
b)	In a fridge		107
c)	In or on top of a kitchen cupboard		108
d)	Near the stove		109
e)	On the floor		110
f)	If other, please specify_____		111

5.9 Where do you keep your milk during winter time?

a)	In the tree near the house		112
b)	In a fridge		113
c)	In or on top of a kitchen cupboard		114
d)	Near the stove		115
e)	On the floor		116
f)	If other, please specify_____		117

5.10 How long after you have milked, do you consume the milk for the first time?

a)	Directly.		118
b)	After 5-10 minutes.		119
c)	After 15-30 minutes.		120
d)	Before 10 am.		121
e)	After 10 am.		122
f)	After 1 in the afternoon.		123
g)	At night.		124

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5.11 How long after you have milked, do you consume the last of the milk?

a) After 5-10 minutes.		125
b) After 15-30 minutes.		126
c) Before 10 am.		127
d) After 10 am.		128
e) After 1 in the afternoom.		129
f) At night.		130
g) If longer, please specify_____		131

5.12 Do you know what the term "hygiene" means?

a) Yes		132
b) No		133

5.13 Do you sometimes consume milk that appears as follows:

a) It has become sour		134
b) It has become thick		135
c) It contains clots		136
d) There are visible signs of dirt/foreign objects in the milk		137
e) There are visible signs of fermentation (bubbles) or mould growth on/in the milk		138
f) There is blood in the milk		139
g) If other, please specify_____		140

5.14 Is personal and general hygiene important when you are milking a cow?

a) Yes		141
b) No		142
c) Sometimes		143

5.15 Do you think there are germs in milk?

a) Yes		144
b) No		145
c) Sometimes		146

5.16 Do you think you can become ill from milk?

a) Yes		147
b) No		148
c) Sometimes		149

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5.17 Do you think that the milk will be bad when your cattle are ill?

a) Yes			150
b) No			151
c) Sometimes			152

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ANNEXURE B

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Tlwaelo tsa ho hama sebakeng sa baahi ba Monyakeng.

LENANE LA DIPOTSO

Ka kopo tshwaya karabo e nepahetseng kapa eo e kgethileng ka ho etsa "X".

(TLHAHISO LESEDING KAOFELA E LENANENG LENA LA DIPOTSO KE SEPHIRI)

1. TLHAHISO LESEDING E AMANANG LE THUTO YA DIPALOPALO TSE BONTSHANG MAEMO A BOPHELO KA HARA SETJHABA JWALOKA MAFU A ITSENG LE TSE DING.

LEBITSO: _____
NOMORO YA MOTHO YA ARABANG DIPOTSO: _____
MOTHO YA TSAMAISANG PUISANO: _____
LETSATSI LA TSWALO LA MOTHO YA ARABANG DIPOTSO:
_____
DILEMO: _____
ATERESE (MOO O DULANG TENG):
_____
_____
_____
MOHALA: (LAPENG)_____
(MOSEBETSING)_____

1.1 Palo ya bana ka hara lelapa?

a)	Ha bayo			1
b)	1			2
c)	2-3			3
d)	3-5			4
e)	5-7			5
f)	Ebang ba feta 7 ka kopo, qaqisa_____			6

1.2 Palo ya batho ba baholo ka hara lelapa?

a)	Ha bayo			7
b)	1			8
c)	2			9
d)	3-4			10
e)	Ebang ba feta 4, ka kopo qaqisa_____			11

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2. MARANGRANG A TSHEBETSO:

2.1 Na o rekisetsa malapa a mang lebese?

a) Ee
b) Tjhee

		12
		13

2.2 O hama kgomo tsa hao makgetlo a ma kae ka letsatsi?

a) Hanngwe
b) Habedi.
c) Makgetlo a mararo
d) Ho feta makgetlo a mararo

		14
		15
		16
		17

2.3 O hamela kgomo tsa hao kae ?

a) Lapeng.
b) Naheng.
c) Sebakeng se kwalehileng ("lesaka") se naheng.
d) Ka tlasa sefate se itseng.
e) Sebakeng seo ke iketseditseng sona sa ho hama
f) Sebakeng se haufinyane se ngodisitsweng sa ho hama.
g) Ebang ho nale tse ding, ka kopo qaqisa_____

		18
		19
		20
		21
		22
		23
		24

3. BOEMO BA DIKGOMO

3.1 O ruile kgomo tse kae?

a) 1
b) 2
c) 3-4
d) 5-6
e) Ebang di feta 6, ka kopo qaqisa_____

		25
		26
		27
		28
		29

3.2 Ke kgomo tse kae tse hangwang ha jwale?

a) 1
b) 2
c) 3-4
d) 5-6
e) Ebang di feta 6, ka kopo qaqisa_____

		30
		31
		32
		33
		34

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3.3 Na ebe kgomo tsa hao di kile tsa kula haufinyane tjena?

a)	Ee			35
b)	Tjhee			36

3.4 Ebang "ee" ke matshwao a feng ao phoofolo eo e ileng ya a bontsha?

a)	Ho hohlola (ho kula ka matshwafong)			37
b)	Letshollo (ho kula ka mpeng)			38
c)	Mengwapo/ho dutla madi/ ho ruruha kapa ho kula ho hong ho bonahalang ha letswele (Mastitis)			39
d)	Ho lahlehelwa ke takatso ya dijo			40
e)	Ho robala ka sefahleho se shebile fatshe (e dula e robetse			
f)	fatshe/e sa kgone ho ema ka maoto),			41
g)	E bang ho nale tse ding, qaqisa_____			42

3.5 Ha kgomo tsa hao di kula, o di nkela ho kae?

a)	Ha ke di nehe kalafo ho hang.			43
b)	Ke di oka ka bo nna.			44
c)	Ke ya SENWES mabapi le meriana le dikeletso.			45
d)	Ke di nkela ngakeng ya selehae ya diphoofolo.			46
e)	Tse ding, ka kopo qaqisa_____			47

3.6 Na ngaka ya diphoofolo kapa rategniki/mategniki o kile a oka kgomo tsa hao?

a)	Ee			48
b)	Tjhee			49

4. MAHLALE A HO HAMA

4.1 Ke mang ya ikarabellang mabapi le ho hama dikgomo (ebang ba feta bong ka kopo ba supe kaofela)?

a)	Ntate			50
b)	Mme			51
c)	Ntatemoholo			52
d)	Nkgono			53
e)	E mong wa bara			54
f)	E mong wa baradi			55
g)	Motswalle kapa moahelani			56
h)	Ebang ho nale ba bang, ka kopo qaqisa_____			57

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4.2 Ke batho ba ba kae ba hamang kgomo tsa hao?

a)	Ke wena feela			58
b)	A le mong			59
c)	Ke nale mothusi a leng mong			60
d)	Ke nale bathusi ba bangata			61

4.3 Na o qalella hanghang ka ho hama hoba kgomo e tswale?

a)	Ee			62
b)	Tjhee			63

4.4 Na ha o hama kgomo o tlamella maoto a ka morao hammoho?

a)	Ee			64
b)	Tjhee			65
c)	Ka nako e nngwe			66

4.5 Na o tle o hlatswe letswele la kgomo pele o qalella ka ho hama?

a)	Ee			67
b)	Tjhee			68
c)	Ka nako e nngwe			69

4.6 Na boloko kapa tshila e itseng ya mantle/moroto tse tswang letsweleng di kena ka lebeseng leo o le hamang?

a)	Ee			70
b)	Tjhee			71
c)	Ka nako e nngwe			72

4.7 Na o tswelapele ka ho hama kgomo e nang le mastitis (tshwaetso e bonahalang ya letswele, dikotwana tseo e leng dikotara tse ommeng tsa letswele, diso/mengwapo kapa matetetso hodima dititi tse utlwang kapele tsa letswele)?

a)	Ee			73
b)	Tjhee			74
c)	Ka nako e nngwe			75

4.8 Na o hamela kgomo e nang le mastitis ka thoko ho tse ding?

a)	Ee			76
b)	Tjhee			77
c)	Ka nako e nngwe			78

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4.9 Na o hama kgomo e shebahalang e kula?

a)	Ee		79
b)	Tjhee		80
c)	Ka nako e nngwe		81

5. TSEBO LE TSHEBEDISO YA BOPHELO BO BOTLE:

5.1 Na o hama dikgomo ka bo wena ha o kula?

a)	Ee		82
b)	Tjhee		83
c)	Ka nako e nngwe		84

5.2 Na o tle o ye ntlwaneng pele o hama dikgomo tsa hao?

a)	Ee		85
b)	Tjhee		86

5.3 O hlapa matsoho a hao neng?

a)	Kamora ho hama		87
b)	Pele o hama		88
c)	Nakong eo o hamang ka yona.		89
d)	Pele le kamora ho hama		90
e)	E seng tsatsi le leng le le leng.		91
f)	Ha o a hlape ho hang.		92

5.4 Na o tshela lebese le letjha le lebese le setseng la tsatsi le ka pele?

a)	Ee		93
b)	Tjhee		94
c)	Ka nako e nngwe		95

5.5 Na o tshela lebese ho tswa ka hara kgamelo o le tshela ka hara setshedi se seng o le tshella ho le sebedisa ka lapeng?

a)	Ee		96
b)	Tjhee		97

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5.6 Ebang o itse ee, o le tshela ka hara eng?

a)	Polastiki kapa botlolo ya galase e nang le sekwahelwana		98
b)	Polastiki kapa botlolo ya galase e se nang sekwahelwana		99
c)	Polastiki kapa emere ya galase e nang le sekwahelwana		100
d)	Polastiki kapa emere ya galase e se nang sekwahelwana		101
e)	Ebang ho nale tse ding, ka kopo qaqisa_____		102

5.7 Na o tle o kwahele setshedi ka ho hong ha o jere lebese o le isa hae?

a)	Ee		103
b)	Tjhee		104
c)	Ka nako e nngwe		105
d)	Tjhee, ho hang		106

5.8 Nakong ya selemo o boloka lebese la hao kae?

a)	Sefateng se haufinyane le ntlo		107
b)	Ka hara sehatsetsi.		108
c)	Ka hara raka ya kitjhene kapa ka hodima yona.		109
d)	Haufi le setofo.		110
e)	Hodima fuluru.		111
f)	Ebang ho nale tse ding, ka kopo qaqisa_____		112

5.9 Nakong ya mariha o boloka lebese la hao kae?

a)	Sefateng se haufinyane le ntlo.		113
b)	Ka hara sehatsetsi.		114
c)	Ka hara raka ya kitjhene kapa ka hodima yona.		115
d)	Haufi le setofo.		116
e)	Hodima fuluru.		117
f)	Ebang ho nale tse ding, ka kopo qaqisa_____		118

5.10 Ho feta nako e kae kamora hoba o hame, ha o tla ja lebese kgetlo la pele?

a)	Ka ho otlolloha.		119
b)	Kamora metsotso e 5-10.		120
c)	Kamora metsotso e 15-30.		121
d)	Pele ho 10 hoseng.		122
e)	Kamora 10 hoseng.		123
f)	Kamora 1 motsheare wa mantsiboya.		124
g)	Bosiu.		125

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5.11 Ho feta nako e kae kamora hoba o hame hore o tle o je lebese la ho qetela?

a)	Kamora metsotso e 5-10.		126
b)	Kamora metsotso e 15-30.		127
c)	Pele ho 10 hoseng.		128
d)	Kamora 10 hoseng.		129
e)	Kamora 1 motsheare wa mantsiboya.		130
f)	Bosiu.		131
g)	Ebang nako e le telele ho feta moo, ka kopo qaqisa _____		132

5.12 Na o tseba hore lereello lena "bophelo bo botle" (hygiene) le bolelang?

a)	Ee		133
b)	Tjhee		134

5.13 Na ka nako e nngwe o tle o je lebese le shebahalang ka tsela ena e latelang:

a)	Hore le se le fetohile bodila.		135
b)	Hore le se le le letenya		136
c)	Hore le nale diqaqa		137
d)	Hore ho nale matshwao a bonahalang a tshila/kapa dintho tse sa tlwaelehang ka hara lebese.		138
e)	Hore ho nale matshwao a bonahalang a ho loella (dipudulwana) kapa hlobo ka hodimo ho kapa ka hara lebese		139
f)	Hore ho nale madi ka hara lebese		140
g)	Ebang ho nale tse ding, ka kopo qaqisa _____		141

5.14 Na boitlhokomelo ba hao ho latela bophelo bo botle kapa bophelo bo botle ka kakaretso ke taba ya bohlokwa ha o hama kgomo?

a)	Ee		142
b)	Tjhee		143
c)	Ka nako e nngwe		144

5.15 Na o nahana hore ho nale dikokwanahloko ka hara lebese?

a)	Ee		145
b)	Tjhee		146
c)	Ka nako e nngwe		147

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5.16 Na o nahana hore o ka kudiswa ke lebese?

a)	Ee		148
b)	Tjhee		149
c)	Ka nako e nngwe		150

5.17 Na o nahana hore lebese le ka ba lebe ebang dikgomo di kula?

a)	Ee		151
b)	Tjhee		152
c)	Ka nako e nngwe		153

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