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BACTERIOLOGICAL QUALITY OF MEAT IN LESOTHO

by

Tabitha Masentle Seeiso

Submitted in partial fulfilment of the requirements for the degree of *Magister Scientiae* in the Department of Paraclinical Sciences, Faculty of Veterinary Science, University of Pretoria

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DEDICATION

I would like to dedicate this work to my late parents Ntate Patrick Patso Seeiso and Mme Marianna Matabitha PS Lekholoane, for their unconditional love, for teaching and showing us that in life someone has to work hard in order to earn a living **(May their souls rest in peace).**

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DECLARATION

I, ***Tabitha Masentle Seeiso,*** hereby declare that the work on which this thesis is based is original and that neither the whole work nor part of it has been, is being , or is to be submitted for another degree at this or any other University.

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SIGNATURE DATE

TABLE OF CONTENTS

LIST OF TABLES

LIST OF PLATES

LIST OF FIGURES

SUMMARY

Title:

BACTERIOLOGICAL QUALITY OF MEAT IN LESOTHO.

Researcher Name	**:**	Dr T. M. Seeiso
Study Supervisor	**:**	Professor C. M. E. McCrindle
Department	**:**	Paraclinical Sciences
Degree	**:**	Magister Scientiae (Veterinary Science)
Institution	**:**	University of Pretoria

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Abstract **:**

Developing countries are faced with a high incidence of food poisoning outbreaks related to the consumption of meat, with obvious economic consequences. During informal slaughter of animals the threat of food poisoning or transfer of lethal zoonoses such as anthrax, is particularly intense.

In 1972 the government legislated “The Abattoir Regulation - Legal Notice No. 27 of 1972”, which mandates slaughtering of animals and meat inspection and control (Government Gazette, 1972). Before that there was no official meat inspection done in the country. Since that time, the legislation has not been updated. The only abattoir was closed in 2003; the country thus has no formal abattoir. Meat is imported and also informally slaughtered and sold illegally.

This study investigated the risk of food-poisoning and zoonoses related to the sale of meat slaughtered informally. It included the extent of the illegal and informal market. In Lesotho, informal slaughter for home consumption is legal but the meat may not be sold (Kingdom of Lesotho, 1972).

The methods used in this study included investigation of the number and location of outlets for informally slaughtered meat in Lesotho. Samples of meat were taken both at informal markets and from imported meat sold at commercial supermarkets. Multistage random sampling was used where the first stage was the district and the second stage was the butcher shops. As a control, samples of legally slaughtered inspected meat were taken from a supermarket in South Africa. These samples were sent for bacteriological examination which included coliform counts and isolation of possible pathogens.

It was found that 40 informal butcheries existed that were selling mainly illegal meat as well as imported legally slaughtered meat. In addition, the commercial supermarkets (n=4) were selling legally imported meat. Geographical coordinates were taken of the existing informal markets and the number of informal butcheries in those markets. This was recorded as a Geographical Information Systems (GIS) map. This map will be used by the veterinary public health and epidemiology sections of Lesotho to monitor informal sales in future, in order to improve the quality of meat sold to Lesotho citizens and prevent food-poisoning by meat products. Samples of meat from local informal butchers (n=100) that were submitted for bacteriological culture (n=100) showed that 63% had coliform counts that were unacceptably high and indicated poor meat hygiene. In comparison, imported meat obtained from

animals slaughtered at registered abattoirs in South Africa and transported to supermarkets in Lesotho, had acceptable levels (Total plate count of > 5)

It was thus concluded that there is an urgent need for improvement in slaughter and meat inspection methods in both rural and urban areas of Lesotho.

The state (both central and local Government) has an important role to play in human and animal health and food safety in the country and strategies must be developed for this. These will include training of veterinary and extension staff as well as butchers, in both the formal and informal markets, on slaughtering procedures and sanitation. In addition, they should facilitate the construction and rehabilitation/upgrading of the existing slaughter slabs in both rural and urban areas of the country, focusing on the main towns not to affect the tourism industry. Lastly, an emphasis should be placed on review of the abattoir regulations, implementation of policies on slaughter procedures and products those that are fit for human consumption, as a way of preventing meat-borne zoonotic diseases, to reduce risks of infection to consumers and to protect meat handlers. Careless handling of waste such as offal, blood and effluent during slaughter can also result in zoonoses and environmental degradation and this should also be addressed.

CHAPTER 1

INTRODUCTION

1.1 Background and justification

1.1.1 Background

The prime objective of a meat hygiene and safety programme is the assurance of wholesomeness and the supply of quality meat sold to the consumer. The presence of a meat inspection system examines grossly apparent abnormalities during the ante-mortem and post mortem examination, but does not recognize complex microbial contamination, which could later precipitate major public health hazards and economic loss in terms of food poisoning and spoilage of meat (Ahmed *et al*., 2002).

Surface contamination of carcasses during slaughter and processing can be reduced by ensuring good manufacturing practices such as hygiene and sanitation of the floor, equipment, and carcasses, with suitable disinfectants and sanitizers (FAO, 2006; Federal Register, 1997). To enable risks involved to be estimated and appropriate measures to be taken, analysis of the slaughtering process has to be complemented by collection of abattoir-specific microbiological monitoring data, in accordance with hazard analysis critical control point (HACCP) principles (Zweifel, Baltzer & Stephan, 2005). According to Zweifel & Stephan (2003a), a regular microbiological examination of carcasses allows reliable conclusions to be drawn with regard to long-term hygienic conditions in abattoirs.

The United States Department of Agriculture has been in the fore in efforts to improve the microbiological safety of meat in general, through the implementation of HACCP systems during the slaughtering process (Kalchayanand *et al*., 2007).

According to Brown *et al*., (2000), in Australia and New Zealand the microbiological testing programmes have been jointly developed by the industry and regulatory agencies, where the primary objective of testing is to verify the control of the processes. Microbiological data are required to correlate microbiological contamination with visible soiling, to identify the microbiological effects of individual operations or processes and to confirm or reject suspected sources of microbiological contaminants on products. Failure to meet microbiological standards precipitates investigative activities aimed at improving control over processes.

1.1.2 Justification

The only abattoir in Lesotho, which was built outside Maseru the capital city in 1985, is no longer operating as it was closed in 2003; therefore there are no specific data that can be used to develop science based HACCP systems to ensure the supply of safe, wholesome meat and meat products to consumers. It is thus also possible that much of the meat consumed is coming from the informal or illegal slaughter of animals.

Meat is an important source of protein and a valuable commodity in resource-poor communities (Datt *et al*., 2003). Inappropriate slaughtering facilities and techniques can compromise food safety. Informal slaughtering places are frequently unhygienic and meat is easily contaminated (Plate1.1). Meat products coming from such conditions often deteriorate rapidly (Datt *et al*., 2003).

Plate 1.1: Slaughter places are frequently contaminated

1.2 Research Question

There are no abattoirs in Lesotho to ensure the supply of safe meat and meat products to the consumers in future, the research questions are:

i) Where does the meat purchased in Lesotho towns originate?

ii) What proportion of meat purchased comes from informal slaughter and what proportion is imported?

iii) What is the surface microbiological status of meat distributed from butcher shops?

iv) Does meat distributed in Lesotho present a risk of hazardous pathogens to the consumer?

1.3. Hypothesis

That a high proportion of the meat sold in Lesotho originates from informal slaughtering and is of a substandard microbiological status and a potential cause of food borne illness.

1.4. Objectives

- To investigate the scope of the meat market by listing the geographic coordinates of all formal and informal butcheries in Lesotho.
- To investigate the source of meat sold in butcher shops in Lesotho.
- To assess the microbiological profile of meat informally slaughtered and sold in the butcher shops in Lesotho in comparison to those sold in supermarkets.
- To determine the prevalence of certain bacteria of public health significance in the meat sold in the butcher shops in Lesotho.
- To make recommendations to improve the safety and quality of meat sold to consumers in Lesotho.

CHAPTER 2

LITERATURE REVIEW

2.1 Background

Lesotho is a landlocked monarchy, completely surrounded by the Republic of South Africa (Fig 2.1). It has a population of 2,125, 262 who are mainly Sotho speaking, although English is the official language and Xhosa and Zulu are also spoken (Index Mundi, 2007). The capital city is Maseru with a population of 170 000 people. Formerly known as Basutoland, it is a member of the Commonwealth of Nations (Ministry of Communications, 2008).

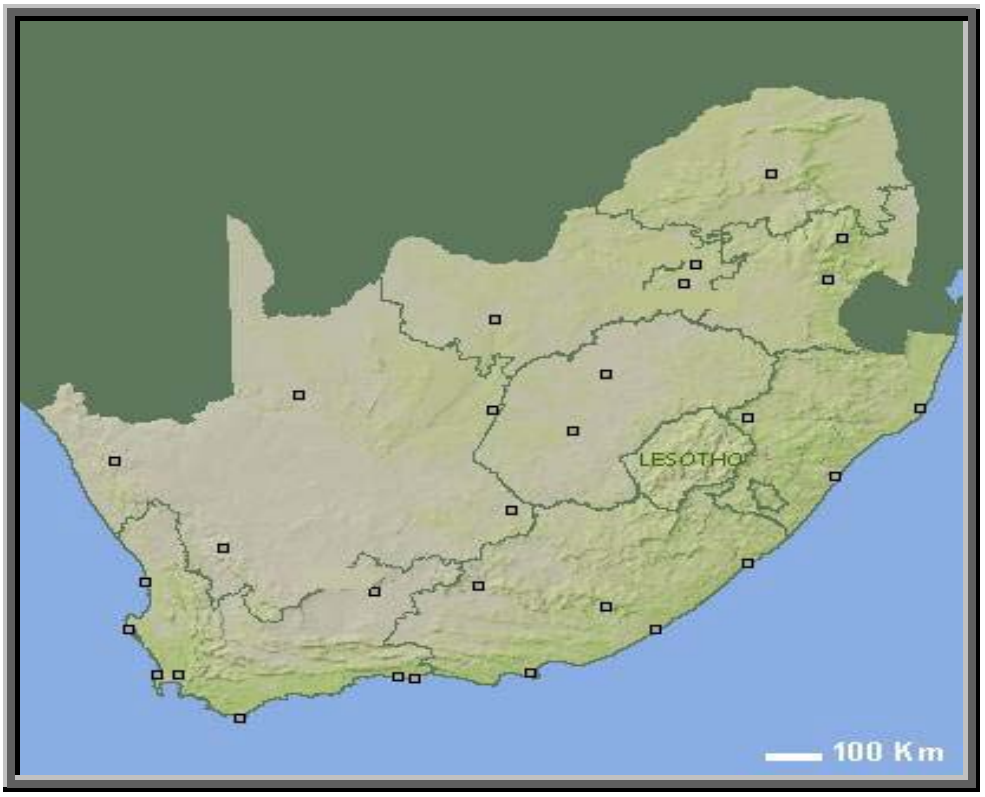

Figure 2.1 Lesotho is a landlocked country surrounded by South Africa

Administratively, Lesotho is divided into ten districts each headed by a district administrator (Fig 2.2). Each district has a capital known as Camptown. The districts are further subdivided into eighty constituencies, which consist of hundred and twenty local community councils (CIA, 2008) .

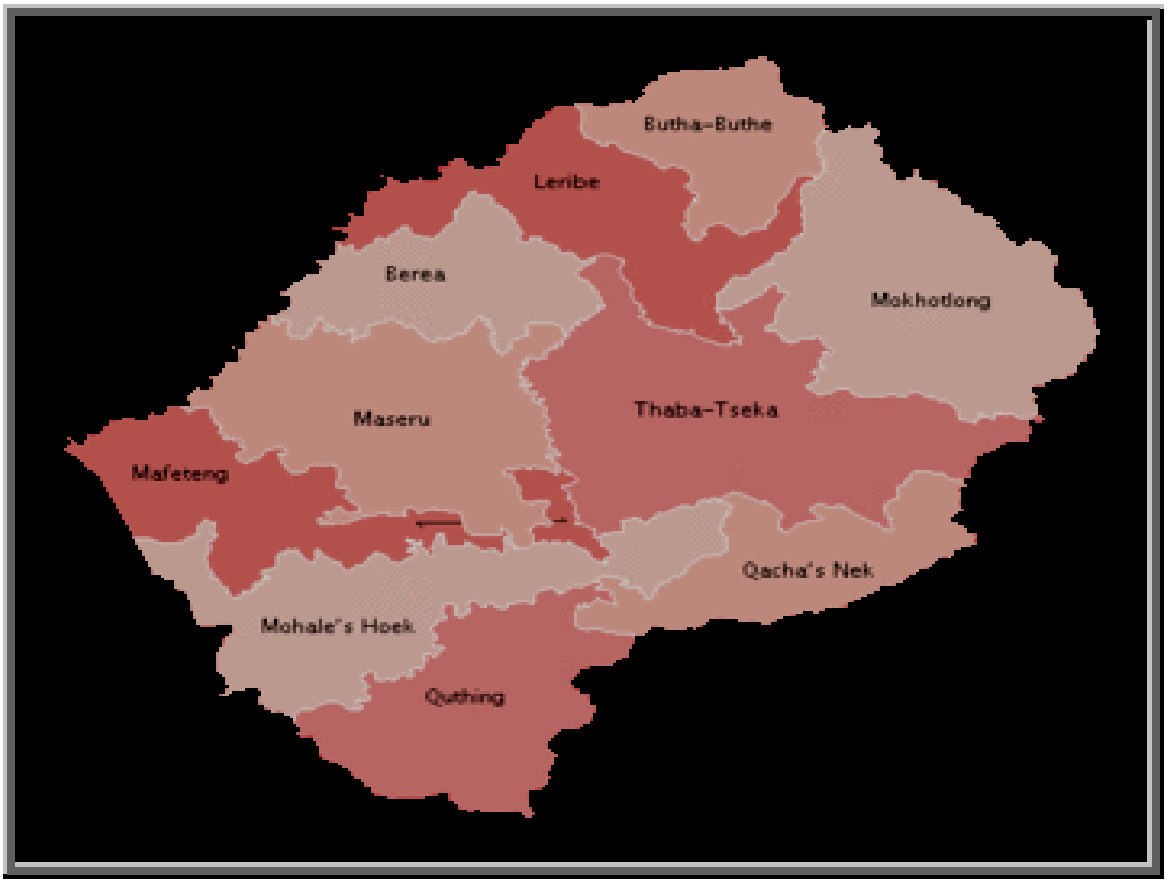

Figure 2.2: Map of Lesotho showing districts

The country offers an opportunity to experience Africa's natural beauty, the simplicity and warmth of its remote inhabitants, and the majestic landscapes of the Maloti Highlands. Lesotho can be explored by car on well-established roads. For the more adventurous a 4 x 4 or the reliable Basotho pony horses which is the traditional form of transport, are more appropriate on rugged terrain (Lekota, 2001).

2.2 Geographic

Lesotho covers 30 355 square km and it is known as the mountain kingdom, because more than 80% of the country is 1,800 meters above sea level. The Geographic co-ordinates are 29 30 S, 28 30 E (CIA, 2008). The mountainous terrain covered by grass makes Lesotho suitable for pastoral animal production activities (SADC, 2008). Cattle, sheep, goats and horses graze in the mountains. Indeed, only 13% of the land mass is arable and few crops are produced (Ministry of communications, 2008).

2.2.1. Climate

The climate is temperate with distinct of summer, autumn, spring, and winter seasons. Lesotho has cool to cold, dry winters, sometimes with deep snow and hot, wet summers. Mountains covered in snow as shown below Figure 2.3.

Figure 2.3. Mountains in Lesotho are covered with snow in winter.

Due to its high altitude, Lesotho remains cooler throughout the year than other regions at the same latitude. Most of the rains fall as summer thunderstorms. Snow

is common between May and September and the mountain peaks can be covered with snow all year round (Climate Zone, 2008).

2.3 Economy

The economy of Lesotho is based on water and electricity sold to South Africa, manufacturing, earnings from the Southern African Customs Union (SACU), agriculture, livestock, and to some extent the earnings of labourers employed in South Africa. Lesotho also exports diamonds, wool, and mohair. It is geographically surrounded by South Africa and economically integrated with it as well. The majority of households subsist on farming or migrant labour, primarily miners in South Africa, for 3 to 9 months of the year. The western lowlands form the main agricultural zone. Almost 50% of the population earns some income through crop cultivation or animal husbandry, with over half the country's income coming from the agricultural sector (Ministry of Communications, 2008).

Water is Lesotho's only significant natural resource. It is being exploited through the 30-year, multi-billion-dollar Lesotho Highlands Water Project (LHWP), which was initiated in 1986. The LHWP is designed to capture, store, and transfer water from the Orange River system and send it to South Africa's Free State and greater Johannesburg area, which features a large concentration of South African industry, population, and agriculture. Completion of the first phase of the project has made Lesotho almost completely self-sufficient in the production of electricity and generated approximately $24 million annually from the sale of electricity and water to South Africa. The World Bank, African Development Bank, European Investment Bank, and many other bilateral donors financed the project. Lesotho has taken advantage of the African Growth and Opportunity Act (AGOA) to become the largest exporter of garments to the U.S. from sub-Saharan Africa. Exports totalled

$466.9 million in 2004. Employment reached 40,000. Asian investors own most factories (BBC, 2008; USDS, 2008).

Lesotho has nearly 6,000 kilometres of unpaved and modern all-weather roads. There is a short rail line (freight) linking Lesotho with South Africa that is totally owned and operated by South Africa. Lesotho is a member of the Southern African Customs Union (SACU) in which tariffs have been eliminated on the trade of goods with other member countries, which include Botswana, Namibia, South Africa, and Swaziland. With the exception of Botswana, these countries also form a common currency and exchange control area known as the Common Monetary Area (CMA). The South African rand can be used interchangeably with the loti, the Lesotho currency (plural: Maloti). One hundred Lisente equal one loti. The loti is at par with the rand (Ministry of Communications, 2008).

2.4 Livestock in Lesotho

The livestock species include sheep and goats, cattle, horses, donkeys and mules (Table 2.1). The value of livestock is inseparable from the Basotho's way of life. Animals are valuable for as a food source, also for draught power, as beasts of burden, for transport and for many cultural rituals. Animal production is dominated by subsistence *vis-à-vis* commercial production typified by exploitative communal use of the rangelands, with a very low off-take rate, the number of animals per household is perceived as wealth (Marake *et al*., 1998).

Table 2.1. Livestock population. (Lesotho Bureau of Statistics 2005/ 2006)

DISTRICT	Cattle	Sheep	Goats	Horses	Donkeys	Pigs
Butha Buthe	34 519	59 621	42 727	3 897	9 801	4 122
Leribe	124 531	107 865	122 758	15 008	26 185	17 353
Berea	82 987	59 925	38 850	5 071	22 353	23 472
Maseru	152 226	152 871	91 276	15 234	24 056	27 781
Mafeteng	76 063	137 817	57 418	5 692	19 320	11 836
Mohales'hoe	48 367	86 177	154 882	9 137	14 796	11 322
Quthing	41 443	98 840	98 730	6 088	6 493	6 621
Qachas'nek	20 672	51 919	15 131	3 581	3 832	2 247
Mokhotlong	41 443	164 234	74 187	8 007	9 367	321
Thaba Tseka	69 141	191 337	156 680	15 571	17 029	3 310
LESOTHO	**691 141**	**1 110 606**	**852 639**	**87 286**	**153 232**	**108 385**

The major problem facing the livestock sector is range deterioration as a result of overstocking. Overstocking also affects livestock productivity, poor nutrition as a result of overstocking gives rise to low reproductive rates, milk production, draught power and fleece weights and ultimately low income from livestock (Marake *et al.*, 1998).

2.4.1 Breeds

Lesotho was the home of large herds of Basotho cattle prior to the great Rinderpest epidemic at the end of the 19th century. Subsequently, these cattle were substantially influenced by black Sanga cattle from the Drakensburg Mountains as well as European breeds. The original Basotho cattle are non-existent today in any significant numbers. The genetic composition of present-day Lesotho cattle compromises the Drankensburg cattle, remnants of the original Basotho, Africander, Friesian as well as Jersey cattle introduced subsequent to the Rinderpest plague (DAGRIS, 2008).

The sheep are of merino type and are raised for the sale of their wool, slaughter as well as for ceremonial purposes. The goats are of the angora type and are raised for the sale of mohair and ceremonial purposes (Hunter, 1987).

2.4.2 Stock theft

In Lesotho livestock theft has become a major problem, which is getting worse and more dangerous. Theft occurs in and between villages, between districts and even across the borders. The loss of livestock has a serious negative effect on household food security as livestock are a vital source of cash to purchase food when agricultural production is low. They are also important for draught power for cultivation (WFP, 2002). This steep rise in livestock theft stood around 47 million rand (about US$ 5.8 million) between 1996 and 1999. The following year, from 1999 to 2000 the amount increased dramatically to 56 million Rand (about US$7 million). The mountainous terrain often makes easy for rustlers to hide stolen stock, and makes it difficult for the police to track animals. This situation also affects the farmers in the Free State Province of South Africa in areas bordering Lesotho, almost 50, 000 animals were lost due to theft from 2000 to 2001 alone. Stolen livestock includes cattle, horses, donkeys, sheep and goats (Utusan Express, 2003).

2.4.3 Marketing of cattle and sheep

Cattle and sheep are most often sold to neighboring farmers as herd replacements or for slaughter, others are sold to butchers, a small number are exported to South Africa (Swallow *et al*, 1986). The Livestock Products Marketing Services (LPMS) were facilitating cattle marketing through the organization of rural auction sales. Most cattle and sheep that were marketed through the auctions, originated from mountain locations. Cattle were then trekked and/ or trucked to Maseru then

proceed to South Africa. The second most important marketing channel which cattle and sheep owners use for sale are informal channels which link butcheries and producers. Most of the animals traded in these informal markets are males, primarily mature males and castrates destined for service as draught animals and ultimately for slaughter (Swallow *et al.*, 1986).

2.5 Meat in Lesotho

Meat is an important source of protein and a valuable commodity in resource-poor communities. In many developing countries, lack of appropriate slaughtering facilities and unsatisfactory slaughtering techniques (as seen in Plates 2.1-2.4 below) are causing unnecessary losses of meat as well as by- products from animal carcasses. Slaughtering places are frequently contaminated and may not be protected against dogs, rodents and insects. Meat products coming from such conditions often deteriorate due to bacterial contamination, especially in warm climates in summer (Datt *et al.*, 2003). Table 2.1 shows the estimated number of animals slaughtered informally, per year, both for home consumption and for sale purpose.

Table 2.2 Animals slaughtered informally (Sephoko.N. Bureau of Statistics 2003-2007)

Year	**Cattle**	**Sheep**	**Goats**	**Pigs**
2003/2004	24 787	58 193	38 538	-
2004/2005	22 651	66 502	40 311	-
2005/2006	23 242	43 352	33 705	25 025
2006/2007	22 095	33 853	36 415	19 412

Plate 2.1 Informal slaughter in the bushes with dog in the background

Plate2.2. Dressing the carcase of an informally slaughtered cow on its skin

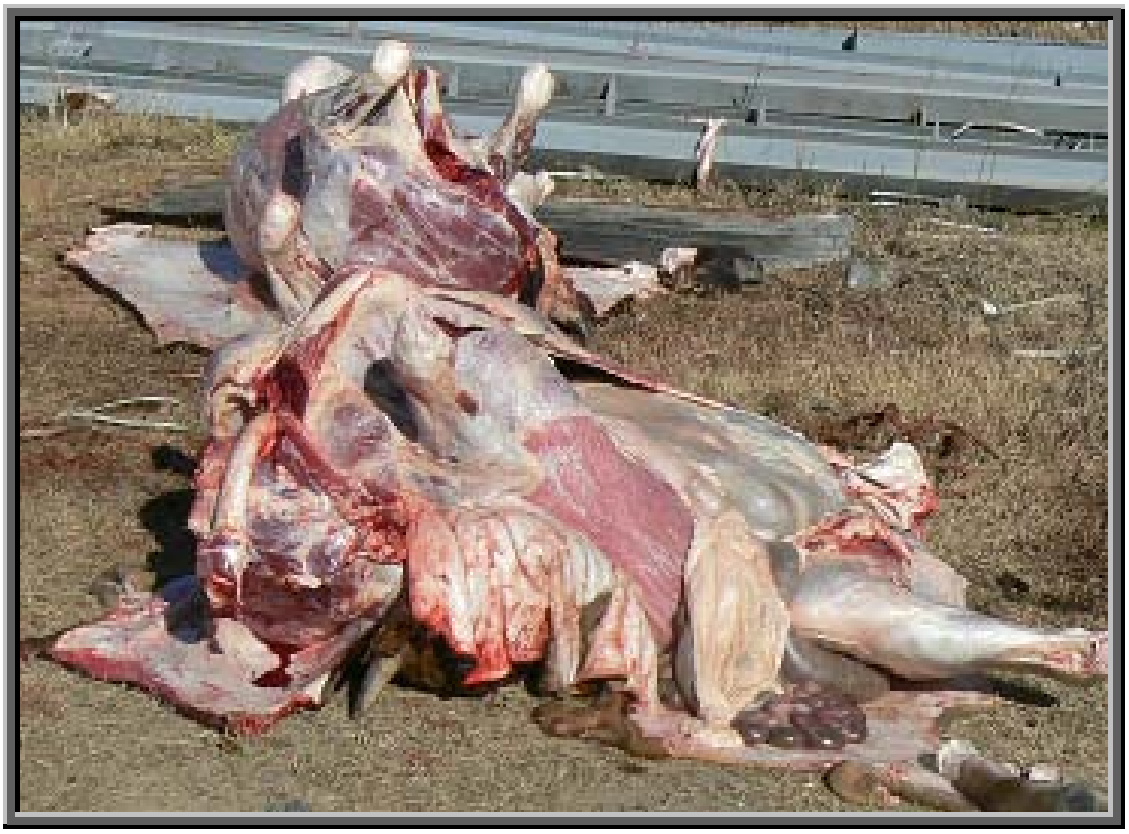

Plate 2.3 Informally slaughtered carcase lie in the dirt with no seperation of innards

Plate 2.4 Slaughtermen wear no protective clothing

It is customary for people in Africa to slaughter animals for weddings and funerals without inspection by competent approved authorities (NDA, 2000). This is even covered by legislation in South Africa as long as the meat is consumed on the same day (Meat Safety Act 2000). However, in 1983 the National Feedlot was opened while in 1985, the Lesotho National Abattoir was established; to serve the nation with high quality inspected meat and meat product with a view that would also lead to export. (Lesotho Agriculture, 2007).

Despite the fact that meat features prominently in the diet of the Basotho people, 1998 was clouded with political riots and unrest in the country, where the abattoir was faced with a crisis during looting of meat and equipment This left the abattoir abandoned, but later that year it was restored back to its original status, until 2003 when it was officially closed down due to financial problems. Since the National abattoir was closed, the nation has been faced with the unacceptable alternative of consuming meat originating from informally slaughtered animals or imported from South Africa.

The risks arising from zoonotic diseases transmitted from consumption of un-inspected meat produced under unsanitary conditions, are a constant threat to human health and thus of major concern to the relevant authorities. While the abattoir was still open, *Taenia saginata* cysts (cysticercosis) were reported to be present in bovine carcasses. This remains as a public health risk, since most of the animals that would have previously been sent to the abattoir are now presumably being slaughtered informally. Cysticercosis has a negative impact on food safety due to its zoonotic potential (FAO 2005).

Due to a lack of implementation of the Meat Inspection Act of 1972 and resultant lack of meat inspection, meat from sick animals or parasite-infected animals can

serve as a source of infection to humans as well as other animals. The only inspected meat available in Lesotho comes from the RSA. Table 2.3 below shows the amount of meat imported annually from the RSA in kg, (veterinary monthly reports on imports 2003- 2008).

Table 2.3. Importation of meat from RSA (Sephoko. N., 2003/2007)

Year	Mutton	Beef	Pork	Chicken
2003-2004	1,526,659	412,638	1,061,845	4,008,240
2004-2005	12,289,181	8,683,678	27,218,099	15,884,344
2005-2006	1, 303,367	584,664	160,019	1,439,744
2006-2007	339,637	1,184,161	4,074	7,503,068

In addition to meat, livestock is also imported from RSA. The number of livestock imported annually into the Maseru District, Lesotho, from South Africa, for informal slaughter is shown in Table 2.4.

Table 2.4: Animals imported from RSA for slaughter (Import-Export reports from Department of Livestock Services 2007 for Maseru district only).

Year	Cattle	Sheep	Goats	Pigs
2003-2004	143	1 124	120	-
2004-2005	486	2844	355	52
2005-2006	451	1 248	7	15
2006-2007	542	1 338	-	-
2007-2008	71	277	25	--

The safety of meat has been at the forefront of societal concern in recent years, and indications exist that challenges to meat safety will continue in the future. The major meat safety issues and related challenges include the need to control traditional as well as new, emerging, or evolving zoonoses, which may have increased virulence and low infectious doses, or of resistance to antibiotics or food related stresses (Sofos, 2008; Doyle *et al*., 2006). Other related concerns include cross-contamination of other foods and water with enteric pathogens of animal origin, treatment and disposal of manure, surveillance of foodborne illness, food

attribution activities and potential use of food safety programs at the farm level. These challenges have become more important due to changes in livestock production, product processing and distribution; increased international trade; changing consumer needs, increased preference for minimally processed products, increased worldwide meat consumption, higher numbers of consumers at risk for infection, as well as increased interest, awareness and scrutiny by consumers (Sofos, 2008).

In Lesotho, meat is marketed through butcher shops. The number of shops per district is shown in Table 2.5.

Table 2.5 Number of butcher shops in Lesotho 2007 (Lesotho Department of Trade and Industry)

DISTRICT	Number of Butcheries
Butha Buthe	14
Leribe	38
Berea	12
Maseru	21
Mafeteng	10
Mohales'hoek	8
Quthing	10
Qachas'nek	10
Mokhotlong	12
Thaba tseka	8
LESOTHO (Total)	145

2.6. Legislation and control of livestock and livestock products

Legislation used by the Department of Livestock Services for the control of livestock and livestock products into the country includes:

- Importation and Exportation of Livestock and Livestock Products Proclamation No. 57 of 1952
- Importation and Exportation of Livestock and Livestock Products (Amendment) Act No. 21 0f 1984

- Stock Disease Proclamation No. 10 of 1896 (Amendment) Act, 1984 Act No. 18 of 1984
- Legal notice No. 27 of 1972 (The Abattoir Regulations 1972). In this regulation it is specified that animals should be killed only at the abattoir.
- Draft Meat Safety Act 2006

2.6.1 Control of livestock and livestock products.

The role of Veterinary services in Lesotho is to control livestock and livestock products and issue import permits which are accompanied by medical health certificates from the exporting country and export permits. Control of livestock and products is done by monitoring of border posts for illegal importation of livestock and livestock products into the country. The importation of meat and livestock is coming from RSA is shown in Tables 2.3 and 2.4. Most of the meat and livestock are imported from the Free State Province as it is close to Lesotho (See Figure 2.4)

Figure 2.4 Proximity of Free State Province of RSA to Lesotho results in import and export**.**

2.7. Informally slaughtered meat and illegal slaughter

Illegal slaughter, according to the Environmental Health Directorate (Department of Health-Government of Western Australia) 2008, is referred to as slaughtering and processing of food animals and the sale of carcasses and meat and meat products without the approval of local government, or compliance with food and safety standards. In many cases, illegal slaughter is informal; however, informal slaughter for home consumption is legal. Grandin & Regenstein (1994) are of the view that illegal slaughter involves an increased proportion of meat from diseased animals as well as emaciated carcasses not fit for human consumption, entering the food chain.

In developing countries, regulations concerning meat inspection and/or control may be inadequate, insufficiently implemented, or non-existent, allowing consumers to be exposed to pathogens, including zoonoses. Slaughter normally takes place in remote farm outbuildings or even outdoors, where the premises usually do not have the necessary facilities for hygienic meat preparation and slaughtermen are not even aware of hygiene requirements (SFELC, 2004). Those performing the slaughter, as well as those handling the meat, are also exposed to zoonoses such as anthrax, brucellosis, leptospirosis, toxoplasmosis, Rift Valley fever and rabies, to name but a few of the most dangerous (WHO, 1995).

The problem of informal slaughter is not restricted to Africa alone. In Brazil it has been reported that 40% of the meat originates from informal slaughtering, a fact that constitutes a major problem for food safety. Meat consumption without sanitary care may cause diseases such as *E.coli*, tuberculosis, salmonellosis and cysticercosis in consumers (Azevedo & Bankuti, 2003).

The problem of illegal slaughter is experienced even in developed countries like the United Kingdom. Informal slaughtering of livestock often takes place at unlicensed premises such as farms, under unsanitary and unhygienic conditions (Food Standards Agency, 2008). In 2002, the BBC reported that eight farmers in western Wales had pleaded guilty to possessing meat unfit for human consumption, after slaughtering sheep illegally on the farm with the intension of selling the meat (BBC news, 2002).

In Scotland, professional well-organized criminals are involved in the illegal meat trade. They use sophisticated processes to transform diseased and decomposing meat into presentable products, good enough to deceive the buyers. They illegally slaughter sheep and goats to produce “smokies” for the ethnic food trade. In addition, there is illegal slaughter of older cattle in contravention of BSE controls, use of couriers to smuggle meat, including bush meat and meat products, through ports and airports, and diversion of animal by-products and meat waste into the human food chain (SFELC, 2004).

Food of animal origin is derived from animals that live in close association with soil, water, air, and other environmental sources of micro-organisms, such as insects, rodents, and birds (Unc & Goss, 2004). Microorganisms including bacteria are an expected and natural occurrence in the environmental and will therefore establish themselves on the hide, hair, hooves, skin, feathers, and feet and in the gastrointestinal tract of live animal’s .There are few, if any, bacteria in the muscle tissue of normal healthy live animals (Gill *et al*., 1978; Mackey & Derrick, 1979).

The hide and viscera of animals entering a slaughter facility are potential source of contamination with pathogenic bacteria. Therefore animals taken for slaughter should be presented as listed below in Table 2.6.

Table 2.6: Hygiene of animals presented for slaughter

- Animals presented for slaughter should be sufficiently clean so that they do not compromise hygienic slaughter and dressing.
- The conditions of holding of animals presented for slaughter should minimize cross - contamination with food-borne pathogens and facilitate efficient slaughter and dressing.
- Ante-mortem inspection should be science- and risk based as appropriate to the circumstances, and should take into account all relevant information from level of primary production.
- Relevant information from primary production where available and results of ante-mortem inspection should be utilized in process of control.

Source: FAO Animal Production and Health Manual.

After slaughter and processing, the bacteria contaminating carcasses are located primarily on the surface. Sources of carcass contamination include contact with the external surface of the animal during hide removal, the gastrointestinal tract of the animal during evisceration (Nottingham, 1982), equipment and utensils used during processing (Mackey & Derrick, 1979), hands and garments of workers exposed during processing and air and water in the processing environment. All workers should wear protective clothing of the type and colour approved (FAO 2006). The level of bacterial contamination of a carcass depends upon the degree of sanitation and hygiene practices during the processing procedure (Buchanan *et al.*, 1995).

The major objectives in hygienic dressing and carcass handling are listed in Table 2.7 below.

Table 2.7 Hygienic dressing and handling carcass

- Prevent contamination of edible portions of the carcass with soiling material from the hides, skins ad pelts, and from the contents of the internal organs;
- Inhibit microbial growth on the surfaces of carcasses or meat;
- Eliminate any carcasses or portions of carcass that are deemed unsuitable for human consumption.

Source FAO Manual 2006

The City of Cape Town in RSA, has defined two main areas of concern for informal slaughter:

- that illegally slaughtered carcasses are not being inspected by trained personnel to ensure that the meat , which offered for sale to the general public, is free of disease and parasites , which could be transmitted to humans(zoonosis); and
- that there is a lack of basic health and hygiene compliance, and a negative impact of the practice on the environment.

They further stated that the following often compromise health and hygiene standards:

- unsuitable stable or kraal structures: these structures do not always facilitate suitable or adequate cleaning or manure removal. This ultimately leads to increased fly breeding, soil pollution, foul odors and other health related nuisances;
- inhumane slaughtering practices: animals are often slaughtered in full view

of the public, and the method of slaughter is not humane as would be in an approved abattoir;

- incorrect handling procedures: the meat handlers do not always wear suitable protective clothing, carcasses are often lying on the ground (contamination and soil pollution), and meat products are not always separated and in a suitable clean containers;
- unhygienic disposal of waste product: waste products are often left lying on the ground, which contributes to soil pollution, fly breeding, odors, rodents' attraction and other health hazards; and
- unsuitable transportation of meat products: vehicles used for the transportation of meat products are often dirty, with the meat being stored on the floor of the vehicle, and this lead to an increased risk of contamination (City of Cape Town 2003).

Klinger (2004) stated that the reasons for illegal and/non-inspected slaughtering of animals in developing countries included:

- the eating habits of the population: people are used to eating meat only from their own animals and trust no one else to slaughter them;
- both Jewish and Islamic religious laws require that animals be slaughtered according to a prescribed method; and
- illegally or home-slaughtered meat is cheaper than inspected meat.

The living animal, however, is not the only source of contamination of foods. Hazards also arise from secondary contamination due to improper handling during harvesting and other processing of raw material.

Handling of food requires certain practices that ensure the safety of those who will eventually eat it. This therefore requires that the consumer is informed about the possible sources of contamination for meat intended for human consumption (Cooke, 1997; McCoubrey, 1989).

2.8 Impacts of informally slaughtered meat

2.8.1 Impacts on human health

Food-borne diseases constitute an important public health problem in both developed and developing countries, although the health and economic aspects are often obscured by an insufficiency of data (Tauxe, 1997; WHO, 1995). They are responsible for high levels of morbidity and mortality in the general population, particularly in high risk groups, such as infants, young children, the elderly and the immuno-compromised (WHO, 1995). While some developed countries have reasonably accurate data on the impact of food-borne diseases, it is rarely possible to derive similar statistics for developing countries because of a lack of surveillance systems for collecting reliable data (Schneider, 2004). It is therefore difficult to estimate what proportion of these diseases can be ascribed to eating contaminated meat, as most cases go to local clinics where treatment is given by nurses and few records are kept. The causes of deaths in rural areas of developing countries are seldom investigated, as autopsies are culturally unacceptable (McCrindle, 2004).

In Lesotho, there is very little information available on the true level of exposure of specific populations to potential hazards, particularly in the case of bacterial diseases transmitted by consumption of meat and meat products. Even at the international level, it is difficult to obtain accurate estimates of microbiological

food-borne diseases. In the United States of America (USA), it is estimated that each year approximately 76 million cases of food-borne disease occur, resulting in 325 000 hospitalization and 5 000 deaths. In England and Wales, food-borne diseases were responsible for 2 366 000 cases, with 21 138 hospitalizations, and 718 deaths (Adak *et al*., 2002; Mead *et a!*., 1999).

2.8.2 Impact on trade

Travel patterns of tourists have changed over time. Bradley (1988) showed that, over the last four generations, the spatial range of travel has increases 10-fold. In particular, air travel has increased the potential spread of disease. Problems include the transmission of food-borne and waterborne diseases, the translocation of insect vectors, the rapid transport of people with sub-clinical disease as well as direct transmission while in the aircraft, and the transmission of zoonoses through animal transport (Royal & Mc Coubrey, 1989). Food safety is a growing global concern not only because of its continuing importance for public health but also of its impact on international trade (Barendsz, 1998).

The food industry is facing tremendous challenges as it strives to meet consumer demands and continues to produce the most affordable, highest quality and safest food. The adoption of HACCP throughout the meat industry probably provides the greatest control and offers assurance of food safety to consumers (Jackson *et al*., 1996).

Food-borne pathogens move with the food across borders and a number of reported outbreaks of food-borne disease have been related to the globalization of the food supply (CDC, 1996; D'Aoust, 1994; Mahon *et al.,* 1996). International trade in raw products and animal feed between regions with a different prevalence level of

food-borne pathogens in the food chain has been shown to contribute to the increasing problem of food-borne disease.

During the last decades the incidence of food-borne diseases such as salmonellosis, campylobacteriosis and enterohaemorrhagic *E. coli* infections, have increased in many parts of the world. A substantial proportion of re-emerging infections are associated with farm animals and meat. Agents include *Salmonella* spp: *Campylobacter* spp: *Yersinia enterocolitica: Escherichia coli:* 0157, *Listeria monocytogenes* and *Toxoplasma gondii* (Nesbakken & Skjerve, 1996; WHO, 1995)

2.8.3 Cruelty to animals

The welfare of animals is of interest to many people in most parts of the world. Concern about the way that animals are treated depends on many factors, including socio-economic conditions, culture, religion and tradition (McCrindle, 1998; Wilkins *et al* 2005). Animals have to be killed to produce meat, or in connection with other farming activities, measures have to be taken to avoid unnecessary suffering, avoidable excitement, pain, or suffering during slaughter or killing and related operations, both inside and outside slaughterhouses (Gregory, 1998). The International Animal Health Organization (OIE) has laid down welfare standards for the humane handling and slaughter of livestock. In 2008 the General Meeting also adopted a definition of animal welfare and reaffirmed the criteria for humane slaughter, long distance transport, as well as culling during disease outbreaks (OIE, 2008). The European Union (EU) stipulates in its animal welfare legislation that livestock must be killed in a way that avoids unnecessary suffering. Cultural and religious practices, as encountered in informal, unsupervised ritual slaughter, can present serious welfare problems as the animals are not correctly restrained and there are no pre-stunning procedures (Wilkins *et al*., 2005).

The informal marketing of livestock in urbanized poor communities creates animal welfare problems due to ignorance, carelessness, lack of compassion and lack of proper facilities, especially in cases of illegal "bush" slaughtering. Kosher, halal and informal ritual slaughters in the African tradition are still issues of welfare concern (EUROPA, 2007; Theart, 2002).

The five-freedoms form a basis on which an evaluation can be made of the welfare of the animal (good or bad) in any particular livestock production system:

- Freedom from thirst , hunger and malnutrition- by ready access to fresh water and diet to maintain full health and vigour;

- Freedom from discomfort- by providing suitable environment including shelter and comfortable resting area;

- Freedom from pain, injury and disease- by preventing or rapid diagnosis and treatment;

- Freedom to express normal behavior – by providing sufficient space, proper facilities and company of the animals own kind;

- Freedom from fear and distress – by ensuring conditions to avoid mental suffering. (Wilkins *et al*., 2005).

In developing countries in Africa, animals for slaughter are transported on foot or on motorized transport that is not designed for animal transport. Animals that are transported by foot often walk for days without adequate rest, water or feed.

The drivers of the animals who often paid move them fast and they are often beaten to reach the destination in the shortest time. It is even suggested that global standards for transport of animals could possibly be used as trade barriers against countries that do not conform to international standards (Appleby *et al*., 2008).

2.9 Sources of food contamination

Sources of food contamination may be **primary,** coming directly from an infected food animal or its secretions, or excretions; or **secondary**, resulting from contamination in handling of food (Marriot & Gravini *et al.*, 2006).

2.9.1 Primary contamination

A food animal may be slaughtered while it is either infected with a microbial pathogen or contaminated with chemical or other residues. In some instances, this presents an occupational hazard to stockyard or abattoir workers, but more often it poses a threat to the consumer. Ante-mortem inspection reveals only a small percentage of these cases (Hubbert *et al.*, 1996)

2.9.2 Secondary contamination

Secondary infection may come from infected humans or live-animal carriers of pathogens, soil, equipment, excreta and hands, nasal discharges, contaminated wounds, contaminated water, insects or feed additives. Infected humans may be the source of contamination at any point in the food chain but are most frequently implicated when preparing food for the table (Hubbert *et al*., 1996).

2.10. Risk associated with informal slaughter

Food provides an ideal medium for the growth and spread of a wide range of pathogens including cholera, botulism, shigellosis and typhoid fever. The informal food trade and the informal slaughtering of animals pose a public health threat due to inadequate hygiene. There is also a negative impact on the environment (Unc & Goss, 2004). Informal marketing also increases public health costs, in as much as products that do not comply with food safety norms imply high risks.

The economic advantages to butchers of choosing the informal market include cost saving through lack of quality control and selling of meat and by-products that should have been discarded. In the particular case of the meat industry, the major financial advantage for the butcher, of choosing informal slaughter, is the use of animals that would otherwise have been rejected due to lack of quality. However these cost savings that benefit the butcher may have direct consequences on public health (Abu-Samra *et al*., 2007; Cape Metro, 1998).

CHAPTER 3

MATERIALS AND METHODS

3.1 Background

All fresh meat becomes contaminated with microorganisms during the slaughter and dressing process, some of these bacteria may include pathogens (these are food poisoning microorganisms). Microbiological testing forms part of HACCP implementation. Testing is used to investigate microbiological effects of the operations within, or affecting, any process, in order to validate the procedure adopted for controlling microbiological contamination of products (Brown *et al*., 2000). Microbiological testing for HACCP must involve the enumerator and indicator organism.

3.1.1 Indicator organisms

Indicator organisms are a group of bacteria that are indicative for the possible presence of organisms of concern, such as pathogens. They are used in assessment of the overall quality of a food and hygiene conditions present during processing. Indicator organisms include: total aerobic counts, coliforms, Enterobacteriaceae, generic *E.coli*, fecal and streptococci (Gill & Mackey in Brown *et al*., 2000).

Several standard tests have been developed to monitor indicator organisms and will be discussed in more detail below.

3.1.2 Enterobacteriaceae

Enterobacteriaceae are gram negative rods that inhibit the large intestine of animals. These are over 25 different genera and over 100 different species in this family of bacteria. Most are commensal, but some of them are pathogenic. All contain endotoxin in their outer membrane and some also excrete exotoxins. They are a major cause of infection (Geomaras *et al.*, 1997).

According to the FAO (1998), the utilization of appropriate farm animal genetic resources, to achieve and maintain sustainable production systems that are capable of responding to human needs, is necessary for national and global food security. The abattoir industry is responsible for conversion of livestock into meat. The quality control of this process remains critical to ensure a safe and wholesome product to consumers. Elimination of carcasses or portions of carcasses with visible lesions of disease from the food chain can be achieved by traditional meat inspection procedures.

3.2. Model system

3.2.1. Model system and justification

A cross-sectional study was conducted on butcher shops that sell meat from informally slaughtered animals in Lesotho, as outlined below:

- Observational study and structured questionnaire – A questionnaire was designed to acquire relevant information from butcher shops. The personal structured interview (Czaja & Blair, 1996; Katzenellenbogen *et al*., 1997), was the method of choice because:

i. The interviewer was able to follow a well-defined structure, preventing the respondent from subjective interpretation of the questions;

ii. It allowed more control over the interview process and people with no or low literacy levels were easily interviewed;

iii. It allowed the interviewer to explain questions unclear to the respondent

3.3. Experimental design and procedures

The questionnaire for the structure interview was designed to determine the source of meat eaten in Lesotho. Samples were collected from the butcher shops and these were sent to a contracted Veterinary Laboratory in Bloemfontein, to isolate and identify bacteria using sampling kits (Analytical and Diagnostics Products cc. RSA)[1] .

3.4. Sampling kits

The sampling kits were purchased from Analytical and Diagnostics Products cc (RSA). Each kit consisted of a sterile glove, sterile template, sterile sponge, and sterile Buffered Peptone water (BPW).

3.5 Study area: Ten districts of Lesotho

All ten districts of Lesotho were taken as the study area (See Map in Fig 3.1), as Lesotho is a small country.

[1] Analytical and Diagnostics Products cc (RSA) P.O.Box 6378, Weltevreden Park, 1715, South Africa.

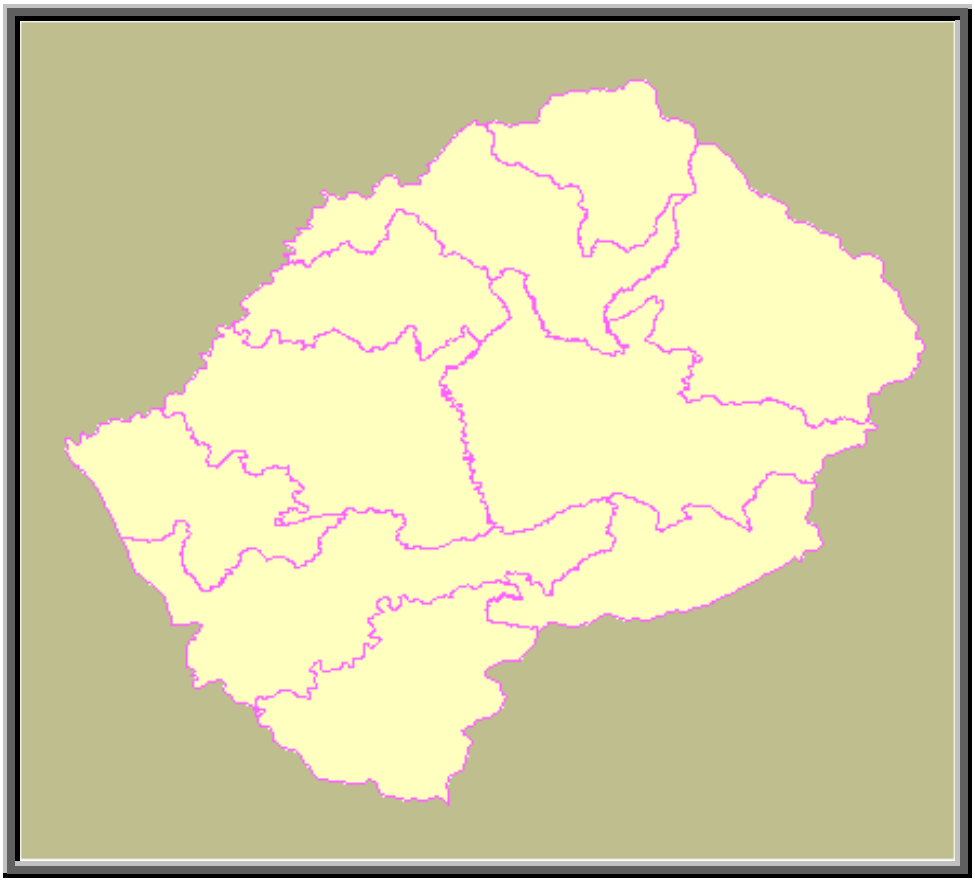

Figure 3.1 Map of Lesotho showing butcher shops in each district (GPS map).

Commercial Butcher shops (e.g. Supermarkets)

Butcher shops in or near informal markets

3.6 Sampling Frame

According to Thrusfield (2005), a sampling frame is a list of all the units within the study area from which samples are taken. Butcher shops were the sampling unit. They were classified into two groups. “Commercial” butcheries were those associated with supermarkets or large shops, mainly in urban areas. “Informal”

butcheries were those located in or close to informal markets. Most of the informal butcheries are also licensed by the Minister of Trade (Trading Enterprise Act of 1999), so are not illegal. From the list of 145 butcher shops a total of (n=44) were randomly selected for sampling.

3.7 Microbiological sampling and analysis

Samples were taken from the surface of carcasses hanging in the butcher shop and were sampled from anatomical carcass sites that included: the flank, the rump, and brisket. Sampling was performed by sponge swabbing procedures described in the USDA/FSIS meat and poultry inspection regulation FSIS-USDA 1996 (Bacon *et al*., 2004). For practical and economic reasons, the swab technique is the most extensively used carcass surface sampling method (Capita *et al*., 2004; Zwivel *et al*., 2005).

A maximum of five carcasses, (cattle, sheep, or pigs) per shop were randomly selected for sampling unless there were less than five in which case all were sampled. The meat samples were taken by using the swabbing method. Samples were aseptically collected and swabs were placed in sterile stomacher bags. The bags were labeled and placed in a cool box to maintain a temperature of +/- 4 degrees Centigrade and transported to the laboratory in Bloemfontein. The total number of samples collected in Lesotho was 100 and 17 samples that were collected from South Africa, from a retailer that sells abattoir slaughtered, inspected meat, were used as controls.

3.8. Collection of meat samples

Plates 3.1-3.10: These are some of the places where samples were taken for the project

Plate 3.1 Buti's butcher shop cold room

Plate 3.2 Floors of Buti's cold room

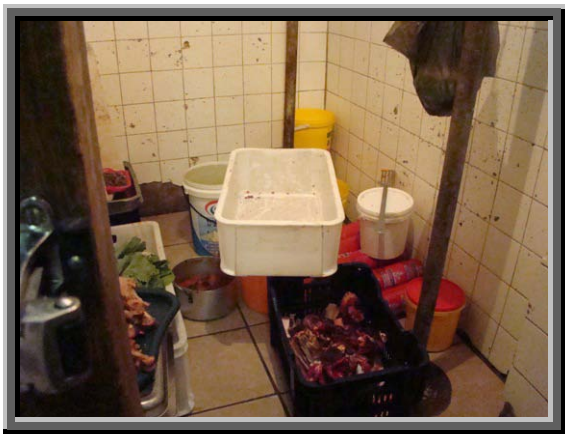

Plate 3.3 Monono cold room floors

Plate 3.4 Monono butcher shop cold room

Plate 3.5 S.M Butcher shop cold room

Plate 3.6 Tip top Butcher shop cold room

Plate 3.7 Tip top coldroom floors

Plate 3.8 Shoprite Sefika coldroom

Plate 3.9 Worker plastic apron Shoprite

Plate 3.10 Shoprite workers in protective clothing

3.9. Methods used for collection of samples:

Sampling of each carcass was done using a 100 cm disposable sterile template and all samples were collected aseptically using sterile gloves. Each sterile sponge was hydrated with 10ml of sterile buffered peptone water. An additional 15ml of the remaining buffered peptone water was added to the sponge, in order to bring the total volume to 25ml. after excess air was expelled. The sponge bags were folded down, labeled and samples were packed with icepacks and shipped to the laboratory. The following sites were considered appropriate for process control:

- Cattle: *neck, brisket, flank, and rump.*
- Sheep, goat: *flank, thorax lateral, brisket, and breast.*
- Pig: *back, jowl (or cheek), hind limb medial (ham), and belly.*
- Horse: *flank, brisket, back, and rump*.

The above sampling procedure was as recommended by the Meat (Hazard Analysis and Critical Control Point) (Scotland) Regulations 2002 No. 234.

3.10. Laboratory testing

Laboratory test were carried out as described below by the qualified technicians, A. Mulder and J. Wentzel at the Veterinary Laboratory in Bloemfontein. When the samples arrived at the Veterinary Laboratory Bloemfontein, they were placed in a refrigerator until the media (Oxoid nr. 325[2]) was prepared and available.

[2] Oxoid: Quantum Biotechnologies (Pty) Ltd., 61 van Breda Street, P.O.Box 943 Krugersdorp 1740, Johannesburg South Africa.

:

Figure 3.2 Dilutions

Figure 3.3 Diagram of media preparation

3.10.1. Diluents

A mass of 1 g of Peptone and 8.5g of NaCl was dissolved in 1 litre of distilled water. The pH was set to 7.0 so that the variance was not more than 0.1 at 20℃. The diluents were divided into 9ml and 200m volumes. The mixtures were sterilized by autoclaving.

3.10.2. Storing of the samples

If frozen, the samples were allowed to thaw for not longer than 18 hours. The fluid was squeezed out of the sponge into the bag provided by the manufacturer. A volume of 1 ml of the fluid was added to 9ml of diluent, to make a 1 in 10 dilution.

The plates were all marked clearly and incubated after once for the plates had set. All plates were incubated at 30 degrees for three days and read using a colony counter.

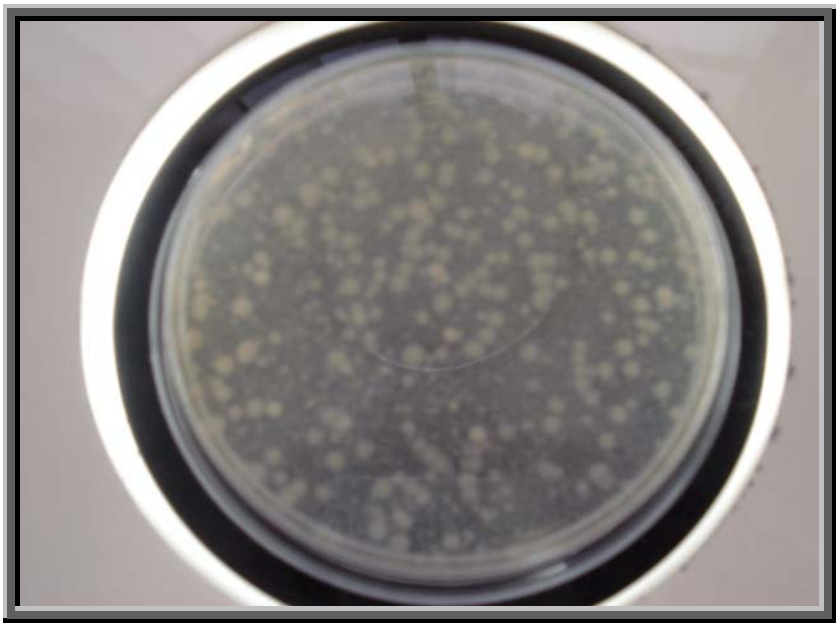

Figure 3.4 Petri dish showing number of colonies after incubation

After 72 hours, the plates were examined for contamination and growth. The colonies of the 1/1000 plate were counted and recorded; the other plates were used as controls to prove that the dilutions were done correctly.

3.10.3 Interpretation of the plate counts:

The plates were interpreted as follows:
<30 To few to count
30 - 300
>300 too many to count

A swab of each sample was taken and plated on Eosin Methylene Blue Agar (Oxoid nr. 0069[3]) and Blood Tryptose Agar (Oxoid nr. CM 0233) to check for the presence of *E.coli*, Salmonella spp., Shigella spp., and other organisms likely to cause food poisoning or indicate contamination of the meat.

[3] Oxoid Ltd. Rapid Microbiology: Wade Road, Basingstoke Hants, RG24 OPW, United Kingdom.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

Meat inspection is commonly perceived as the sanitary control of slaughter animals and meat. The aim of meat inspection is to provide safe and wholesome meat for human consumption. Herenda *et al*., (2000) further confirms that the responsibility of achieving this objective lies primarily within the relevant public health authorities (in the Ministry of Agriculture and the Ministry of Health represented by the veterinarians and health inspectors respectively).

There is no formal abattoir in Lesotho and it was found that animals are also imported from South Africa for slaughter. It was thus presumed that a large proportion of meat consumed came from informal slaughter. This was confirmed from interviews and data obtained on the number of animals slaughtered in Lesotho by butchers, as it was found that about 80% of the meat consumed comes from informal slaughtering.

Over the period of the study, a total of 117 samples were collected. Of these 100 originated from informal butcher shops and commercial supermarkets in Lesotho (4) and 17 samples were collected from a commercial supermarket in RSA (Shoprite Ladybrand, Free State Province). The origins of samples are shown in Table 4.1. Carcasses from different species of animals (cattle, sheep and pigs) were sampled. Data will be presented on the levels of bacterial contamination found in these samples.

Table 4.1: Details of the butcher shops where samples were collected

District	Butcher shop name	Name of Owner	Contact/ address
Maseru	Monono	Moorosi Motsapi	Box 7771 Maseru
	S M	Semoli Semoli	Box 11406
	Buti	Buti Mankopane	Box 596
	Tip Top	Ramatlapeng Poko	Box 745
	Benzons	Thabo B	Maseru
	Check out	Checkout Co	Maseru
	Hillside	Makhakhe M	Maseru
	Machache	Swanapoel M	Maseru
	Shoprite Sefika	Shoprite Co	Maseru
	Shoprite LNDC	Shoprite Co	Maseru
Leribe	Kopanang Basotho	Sipho Vumisa	Box 790
	Standard	Ntaoleng Motsumi	Box 352
	Kopanang ii	Sipho Vumisa	Box 790
	Shoprite	Shoprite	Leribe
Berea	TY meat Suppliers	Mapetla Phomolo	Box 1134
	Roadside	Makoali Lekholoane	Box 103
	Taung	Mosebi Lekatsa	Box 244
	Holy Cross	Ngaka Mofo	Box 455
Mafeteng	Standard	George Janki	Mafeteng
	Farm Fresh	Ben Maphathe	Mafeteng
	Shoprite	Shoprite	Mafeteng
Butha- buthe	Welcome	Fransisco Vincenti	Box 699
	Elangeni	Fomesa Chabalala	Box 116
	Machabeng	Masefatsane Moloi	Box 526
	Litsoakotleng	Mapoelo Tsotetsi	Box 950
	Bakuena	Mantsane Selebalo	Box 307
Mohales'hoek	Mafoso Fresh Meat	Willie Mafoso	Mohales'hoek
	Edma	Mohlekoa Mohlekoa	Box 255
	KBT	Frasers Co.	Box 4
	MK	L. Kou	Mohales'hoek
Quthing	Frazers	Frazers Co.	Quthing
	Sehlekehleke	Moshe Sesoane	Box 123
	Liphakoe	Lehlohonolo	Box 86
Mokhotlong	Thialala	Franscis Mohloki	Box 83
	Tsoana makhulo	Nkoebela Makhakhe	Mokhotlong
	Phokeng	Mohlomi Maputle	Box 54
	Farm products	Maputle Maputle	Box 54
Thaba-tseka	Slaughter slab	Government	Thaba Tseka
	Lilala	Francis Mokhethi	Thaba-tseka
	Mamaroala	Bereng Mosala	Box 177
	Star	Jane M	
Qachas'nek	City	Rasehlooho Shata	Box 212
	Bataung	Tebello Khoromeng	Box 47
	Likepolane	Mahlomola Pelesa	Box 279
	Qachas'nek	Mapolo Shoaepane	Box 187
RSA	Ladybrand Shoprite	Shoprite	RSA

4.2 Location of butcheries in Lesotho

Figure 3.1 is a GIS map of Lesotho with the GPS co-ordinates of the 44 butcheries that were sampled.

4.3 Results of interviews with butchers

Forty four questionnaires were analysed. The average time of ownership of the butcher shops was 7 years. Many of the butchers have been doing this for a long time, as the maximum time of ownership was 20 years; in contrast, the shortest time was 1 year.

4.3.1 Educational level

The level of education from the respondents was between primary and secondary school education, average had a tertiary level. Educated butcher shop owners have easier access to resources (e.g. extension and veterinary services). Mostly these are the people who are constantly importing meat from RSA.
The formal education level of the butchers is shown in Fig 4.1 as a pie chart below

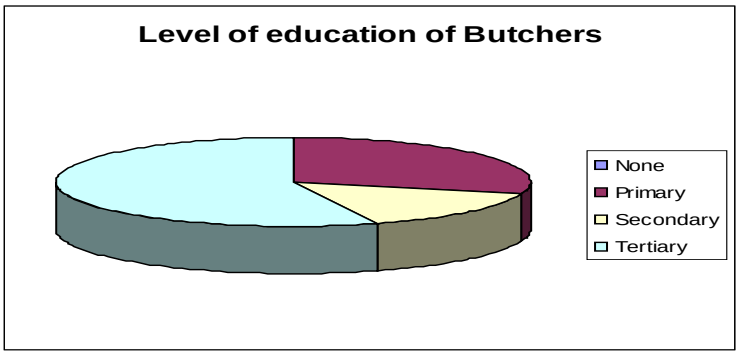

Figure 4.1 Level of education of butchers (n=44)

Previous training was received by one butcher from Mohales'hoek who was working for the National Abattoir before its closure, 43 never had any formal training, and they only received on job training by the state Veterinary Services (staff from the section of Veterinary Public Health, during the inspection of food establishments).

4.3.2. Main sources of water and power supply

Most of the butcher shops (n=43) are connected to the Water and Sewerage Authority of Lesotho, which is the main supplier of the water control system. Only one butcher shop in Botha-Bothe did not have a water system as he bought water from other people and collected it in a tank. All of them, except one who has a gas refrigerator as she does not own a cold room, were connected to the electricity network supplied by the Lesotho Electricity Corporation. In all cases meat was cut and stored in refrigerators immediately after slaughter.

Table 4.2: Type of sanitary facilities from interviewed respondents

District	Pit Latrine	Waterborne Toilet	Neither Pit/Water
Thaba-tseka (n=4)	4	0	0
Mokhotlong (n=4)	4	0	0
Bothab-Bothe(n=5)	2	3	0
Leribe(n=4)	3	1	0
Berea(n=4)	1	3	0
Maseru (n=10)	1	9	0
Mafeteng (n=3)	0	3	0
Mohales'hoek (n=4)	1	3	0
Quthing (n=3)	1	2	0
Qachas'nek (n=4)	1	3	0

4.3.3 Respondents knowledge about meat inspection

The respondents (the butcher shop owners) were asked if they knew the reasons why meat inspections were carried out and whether they considered them to be of any importance. It was found that all of the respondents from Maseru, Mafeteng and Mohales'hoek were knowledgeable about meat inspection and why it should be carried out, while respondents from other districts were not quite sure, thinking it as waste of money.

The high level of knowledge about meat inspection, recorded for Maseru could be related to the urban orientation where the National Abattoir was situated and in Mohales'hoek one of the butcher shops was the former manger of the abattoir. In particular, the fact that the two major towns, and, have a better standard of living and strategic town management. In general the level of understanding of Meat Hygiene/ Inspection is very low.

Table 4.3: Knowledge of respondents about meat inspection

District	Yes	No
Thaba-tseka	2	2
Mokhotlong	0	4
Bothabothe	2	3
Leribe	2	2
Berea	2	2
Maseru	10	0
Mafeteng	3	0
Mohales'hoek	3	0
Quthing	2	2
Qachas'nek	1	3

The closure of the only abattoir, which is far from the other districts.

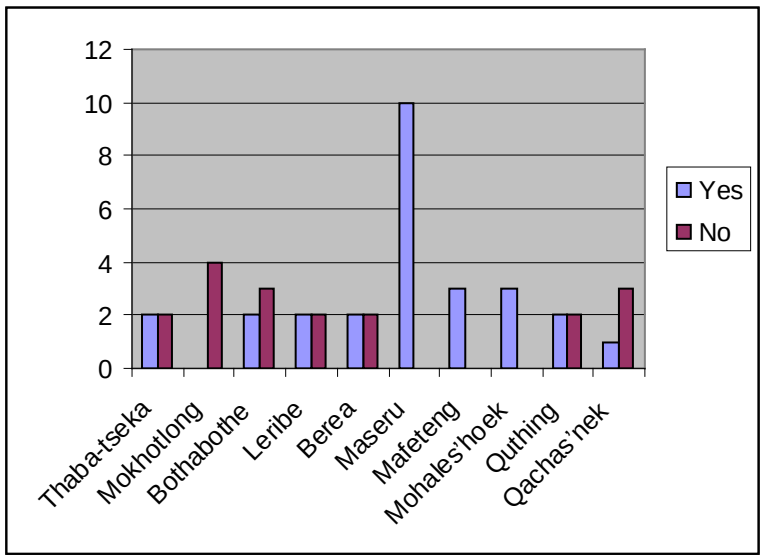

Figure 4.2: Knowledge of respondents about meat inspection

In the lowlands districts the level of knowledge was higher than that found in the mountainous districts (Figure 4.2)

4.4. Type and origin of animals and meat sold

As shown in Table 2.4 animals were imported into Lesotho by the butchers for slaughter and originated mainly from the Free State Province. These animals were transported by butchers using their own vehicles, no special transport was used. The number of animals bought to be slaughtered varied according to demand and size of the business. On average four cattle, eight sheep and four pigs were slaughtered per week.

Meat imported from RSA was brought by a special refrigerated truck from the suppliers which were registered abattoirs. Table 2.3 shows the amount of meat imported which was mostly sold by commercial supermarkets (Shoprite) and a few local butcher shops around Maseru and Mohales'hoek.

4.4.1. Slaughtering of animals

Slaughter stock is bought from RSA by butchers who do not have their own livestock or bought locally from other farmers. However some of the butcher shops own the livestock that they slaughter.

There are three main types of informal slaughter used in Lesotho. The first is the hiring of untrained slaughtermen who slaughter mainly “in the bush” (See Plate 2.1), the second is the partly formal slaughter at a government licensed slaughter slab, the third is the use of their own employees as slaughter men. These were often labourers to slaughtered livestock “in the bush” or in the back yard of the butcher shop.

The relative proportions of each type of slaughter are shown in Table 4.4 below.

Table 4.4 who slaughter the animals for the butcher shops?

District	Hired slaughterers	Slaughter Slab	Own people
Thaba-tseka	1	1	0
Mokhotlong	4	0	0
Bothabothe	3	1	0
Leribe	4	0	0
Berea	4	0	0
Maseru	3	0	1
Mafeteng	1	0	0
Mohales’hoek	2	0	0
Quthing	2	2	0
Qachas’nek	2	0	2

Key:

Hired slaughtermen: Butcher hires slaughtermen to kill and cut up the animals.

Slaughter slab: Butcher takes the animals to a government licensed slaughter slab.

Own people: Butcher uses his own employees or labourers to slaughter the cattle.

The three categories of slaughtermen are described in more detail below.

4.4.2 Hired slaughtermen

Unfortunately, most of these have no specific training and some experience. They will do the slaughtering for several different butcher shops in an area and charge per animal. They usually ask for the pluck and tripe which they consume themselves. They do not take hygienic precautions, know little about animal welfare and usually do not stun prior to cutting the throat. No protective clothing is worn. The ingesta and blood are left at the slaughter scene, usually to be consumed by stray dogs and birds.

4.4.3 State slaughter slabs

These are registered in terms of Abattoir Act 1972 Act – regulations Legal Notice No.27 of 1972. Plate 4.1 below shows a typical slaughter slab owned and monitored under local government and inspection is done by Inspectors from Ministry of Health.

Plate 4.1. Slaughter slab in Berea district.

4.4.4 Employees of butchers

The main advantage of employees is that the same people are always used and opportunities for training exist. In other respects they are the same as the hired slaughtermen. Butchers seem to be unaware of the provisions of occupational health legislation (Legal notice No.25 of 1973: Public Health regulations).

Livestock are slaughtered mainly around the business premises and some are slaughtered at places of residence and transported by ordinary vans to the butcher shops, the carcasses being covered or each wrapped in its own skin. They are not washed after dressing but hung up to dry, then transported to the butcher shop. Animals are not stunned. They are often slaughtered inhumanely and are bled and skinned while lying on the ground as shown in Plates 2.1-2.4.

4.5. Personal hygiene

Personal hygiene is highly compromised as people who are slaughtering these animals rarely appear to wash their body or hands and use their own clothes without protective clothing as shown in Plates 2.2 and 2.4. These are hired people (casual labour) who are never taken for medical check ups and who can thus easily transmit diseases.

4.6 Samples taken per species

A total number of 117 (n=117) samples were collected using a sponge for **s**wabbing as describe previously. Of these, 100 originated locally and 17 were collected from the commercial supermarket in the RSA. The numbers of samples taken per species

are shown below in Table 4.5. It can be seen that of the 100 swabs submitted to Bloemfontein, 62 were from cattle, 32 from sheep and 6 from pigs.

Table 4. 5 Number of samples per species:

District	Cattle	Sheep	Pigs
Thaba-tseka	4	0	0
Mokhotlong	6	0	0
Bothabothe	6	2	1
Leribe	8	2	1
Berea	6	6	1
Maseru	10	6	2
Mafeteng	6	4	1
Mohales'hoek	4	6	0
Quthing	6	4	0
Qachas'nek	6	2	0
Total number	62	32	6

Five animals were randomly sampled by swabbing at each shop, unless there were less than 5, in which case all animals were sampled.

The number of specimens taken per district is reflected in Table 4.5, which shows the total number of samples taken from both commercial and informal butchers in each district, per species.

4.7. Laboratory results

The samples were collected as per the procedure recommended by the FAO manual; these samples were transferred to the laboratory to Bloemfontein in sterile stomacher bags, on ice, for culture and cell counts were done on 1:1000 dilutions. The results are shown in Table 4.6 below.

Table 4.6: Results by species: number of positive cultures (n=100)

Species	<30	>30	TMTC	E coli /salmonella	Fungi/ *Staphylococcus aureus.*
Bovine	0	11	41	6	4
Ovine	0	8	19	3	2
Porcine	0	2	3	1	0
Total (n=100)	0	21	63	10	6

Key:

TMTC: Too many to count

Table: 4.7 Acceptable ranges (Source: Meat HACCP (Scotland) Regulations 2002 No. 234)

Daily log mean values (cfu/cm^2	***Acceptable range***	***Marginal range (>m but •M)***	***Unacceptable range (> M)***
Total viable counts (TVC)	***Cattle/sheep/goat/horse*** < 3.5 log	***Cattle/pig/sheep/goat/horse*** 3.5 log (pig: 4.0 log) – 5.0 log	***Cattle/pig/sheep/goat/horse*** > 5.0 log
Total viable counts (TVC)	< 3.5 log	1.5 log (pig: 2.0 log) – 2.5 log (pig: 3.0 log)	> 2.5 log (pig > 3.0 log)

Table 4.8: Values for the number of colonies for testing of surfaces

	Acceptable range	***Unacceptable range***
Total viable counts (TVC)	0 – 10/ cm^2	> 10/ cm^2
Enterobacteriaceae	0 – 1/ cm^2	> 1/ cm^2

4.8. Discussion:

The high coliform counts suggested that meat marketed in Lesotho was not fit for human consumption and indicated poor hygiene quality of meat. Contamination with coliforms may occur during slaughtering, cutting and dressing of the carcasses, soiled hands and by the butcher's own clothing because no protective clothing is

used. Both the knives used for slaughtering and cutting or contaminated water are important sources of coliforms in meat. Moreover, Bell *et al*., (1993) reported that high number of bacteria could be transferred from the fleece/skin of the animal to the carcass surface during hide/skin removal.

Another reason for contaminated meat found during this study might be poor maintenance of the cold chain during transportation. The production of such poor quality meat predisposes it to early spoilage as well as posing a threat to the health of the consumer. Serious attention must be given to adoption of hygienic measures during slaughter, handling and transportation of both meat and meat products, in order to produce a suitable product which will not cause hazards to the end user.

Results from meat samples obtained from Shoprite RSA, that were used as a control (Table 4.9) showed much lower bacterial counts that those from the butcher shops in Lesotho.

Table 4.9 Results from RSA Shoprite Ladybrand

Specie	Total Bacterial Count	Comments	Gradation Point
Ovine	5	Very Good	5
Ovine	1	Very Good	5
Ovine	3	Very Good	5
Ovine	3	Very Good	5
Bovine	0	Very Good	5
Bovine	0	Very Good	5
Porcine	5	Very Good	5

The results obtained from shops in different districts of Lesotho are shown in Table 4.10.

Table 4.10: Results by District

District	<30	>30	TMTC	E coli/salm	Fungi/ *S. aureus**
Thaba-tseka	0	4	0	0	0
Mokhotlong	0	4	2	0	0
Bothabothe	0	4	5	0	0
Leribe	0	2	5	4	0
Berea	0	3	5	2	3(bovine2*, porcine*)
Maseru	0	4	11	0	3 (bovine*, bovine*, ovine*)
Mafeteng	0	0	7	3	0
Mohales'hoek	0	0	9	1	0
0Quthing	0	0	9	0	1Fungi
Qachas'nek	0	0	6	1	1

4.8.1. *Staphylococcus aureus*

S. aureus is a facultative anaerobic Gram-positive coccus that is catalase positive and oxidase negative. Under the microscope they usually appear as grape-like clusters. They can be found in the air, dust, water and human faeces, and can be present on clothing and utensils handled by human. *Staphylococci* are a normal part of the microflora of the nose throat and skin and only *S aureus* is considered to be pathogenic. They can be found on other parts of the body but the nasal passage is the most significant site. The carrier rate varies with different populations and studies have found a carriage rate of 10-40% in adults outside the hospital environment. Carriage may be intermittent or continuous over a long period of time. Approximately 15-20% of humans carry enterotoxin producing Staphylococci on their skins or in their upper respiratory tract, pharynx and mouth.

Various types of skin eruptions and inflammations in humans (e.g. boils, acne, styes) as well as wounds can harbour large numbers of these micro-organisms.
Animals and poultry can also carry *S. aureus* on various parts of their bodies. Udders and teat canals in cows can a source of *S. aureus*. It can be isolated from the

milk of healthy cows and high levels are found in milk from cows suffering from mastitis.

High levels are also found on the skin of pigs and some strains have become endemic in poultry processing plants. Strains from animal sources are less likely to produce endotoxins than strains from human sources.
From the two districts Maseru and Berea results it was found that meat samples were contaminated with *Staphylococcus aureus*.

4.9. Case study of anthrax in humans due to informal slaughter

Lesotho is enzootic for anthrax. Human cases were registered in 1995 (n=8) and 1996 (n=1) which resulted from slaughter and consumption of illegally slaughtered cattle (Veterinary Reports, 1995-2008). In 2008, reports coming from the Ministry of Health confirmed human deaths (n=5) due to consumption of animals that died from anthrax, with three patients having been hospitalized. It is possible that other deaths occurred that were not recorded as the people were not brought for treatment in time and were buried locally. Plate 4.2 shows a child with a cutaneous lesion.

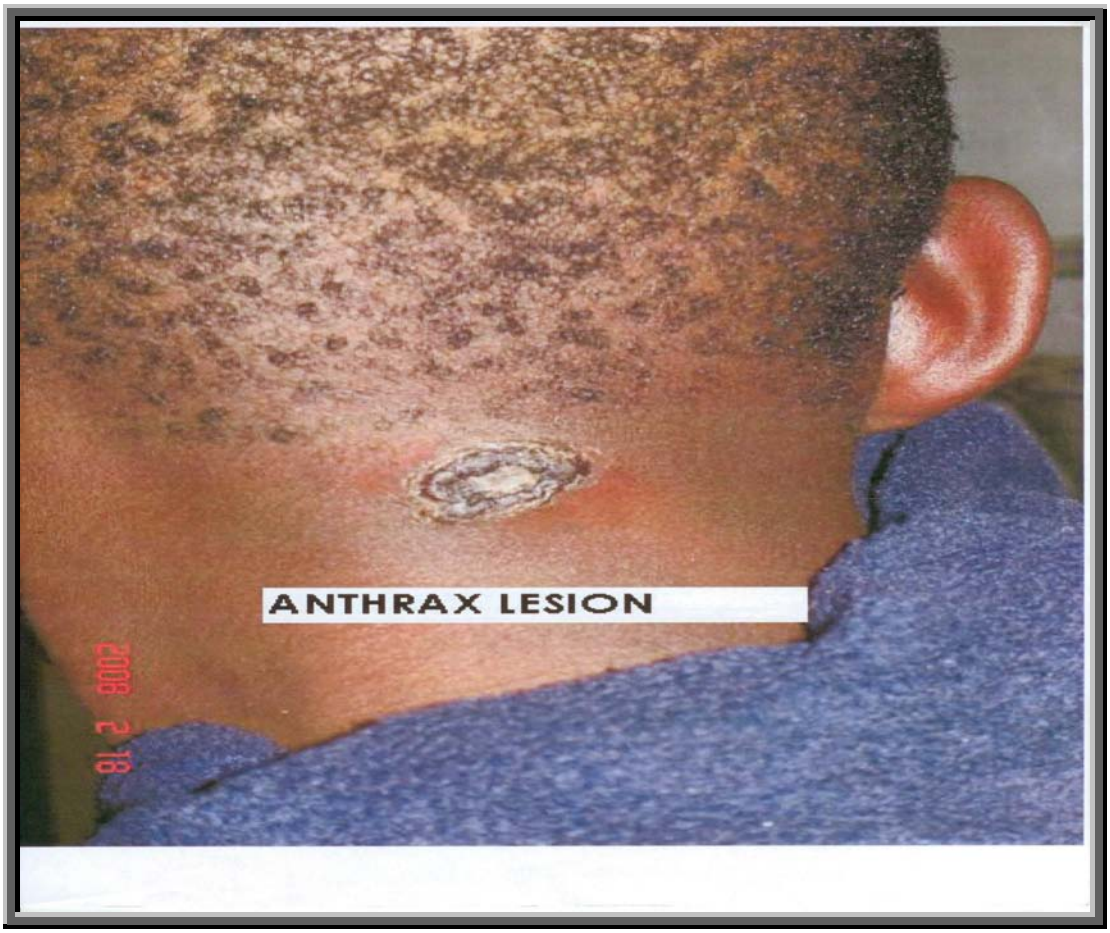

Plate 4.2: Patient with anthrax lesion in Mafeteng hospital, February, 2008

Poor people are more at risk of contracting many zoonoses. Meat from dying animals slaughtered near the farm or in back yards are all bought or eaten by the poorest consumers. The consumption of undercooked meat and handling of raw meat during the informal slaughter process is also a possible way of contracting these zoonotic diseases. Animals slaughtered for human consumption should be healthy and disease free to avoid human deaths.

CHAPTER 5

CONCLUSIONS AND RECOMMMENDATIONS

5.1. Conclusion:

It is of outmost importance to ensure that the meat we buy and which is eaten by our families in Lesotho is healthy and safe, and does not pose a health risk to consumers.

The safest way to ensure the above is to have animals slaughtered at approved places (abattoirs or slaughter slabs) where carcasses are inspected by competent authorities (meat inspectors). In that case, if meat is found to be unsafe or unsound at such places that carcass or meat is condemned and destroyed.

As an outcome of this study, it has been found or estimated that about 80% of animals are slaughtered informally among rural and urban communities. In these communities many family members participate in the slaughter process; the cleaning of the carcass or preparation of meat (a typical example being anthrax where fatal cases occurred). Thus most of the meat consumed in the country comes from informal slaughter. The use of a questionnaire as a way of interviewing butchers confirmed that most of the meat sold came from informal slaughter.

It also noted that customers preferred to buy meat from informal markets rather than inspected meat from formal markets, because the meat is cheaper, although informal conversations during the study indicated that some of them appear to be well aware of the health risks that might result.

Four areas of concern have been highlighted by this research:

i) The illegally slaughtered carcasses are not being inspected by trained personnel to ensure that the meat, which is offered for sale to the general public, is free of diseases and parasites (tapeworm) which could be transmitted to humans (zoonosis).

ii) The lack of basic health and hygiene compliance.

iii) The potential negative impact on the environment, observed during informal slaughter where no attempt was being made to dispose of effluents, by products and inedible offal.

iv) The presence of vermin and insects such as flies are also of public health concern and scavenging dogs could spread pathogens (especially any meat containing anthrax spores) over a distance.

In rural and urban communities many family members participate in the informal slaughter process so increasing the risk of disease. Unhygienic slaughter and dressing procedures observed, as well as unsatisfactory transport of meat and deficiencies in the cold chain also contributed to carcase contamination.

The high total aerobic counts and high levels of *Coliforms* indicate a crucial need to improve quality management systems.

5.2. Recommendations

The Government of Lesotho should immediately take urgent measures to improve the conditions under which the present informal slaughtering of animals for human

consumption and marketing of un-inspected meat is carried throughout the country.

Particular attention should be focused on the rehabilitation of the existing slaughter slabs in the districts, which are the responsibilities of the local government structures. The following are important:

- Organization of training courses for slaughter slabs workers to improve on the humane and hygienic slaughtering of animals. to avoid unnecessary suffering, improve meat quality, reduce losses and increase profitability and financial returns to the farmers;

- Introduction of effective meat inspection procedures and insisting that only stamped carcasses are permitted for sale to butcher shops and consumers ;

- Establishment of standard procedures to improve the occupational heath of butchers, meat handlers and the consumers;

- Improvement in the methods used currently so as waste disposal to prevent pollution of the environment;

- Changes to the law to improve consumer protection and reduce the risk of disease;

- Encouraging rural areas to adopt hygienic slaughtering conditions;

- Implementing surveillance and risk assessment for other meat-borne diseases in order to assess the transmission and impact of food borne disease;

- Implement shared responsibility linked to food chain policies of the government, food industries , manufacturing and catering institutions as well as consumers; and collective consensus should be reached to implement recommendations shown in Table 5.1.

Table 5.1 Recommendations based on shared responsibilities

Government	Industries, Manufactures& Caterers	Consumers
Food regulation & law Enforcement	Good practices for primary production , distribution & final preparation	Consumer expectation and demand
Advice to Industry	Quality assurances	Acquire appropriate knowledge & attitudes
Information gathering, basic research and epidemiology	Training of managers and food handlers	Acceptance of responsibility and participation
Consumer education	Appropriate process technology equipment and facilities	Utilize good practices

Re-opening of the abattoir and re-conditioning of the districts slaughter slabs as well as proper licensing of butcher shops crucial so is compliance with legislated standards, It appeared that there were financial problems that led to the closure of the abattoir and steps should be taken to investigate cost-effective models or international donors, to make meat inspection a profitable reality. It may be necessary for the state to partly subsidise a new abattoir in the interests of public health.

CHAPTER 6

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APPENDIX A

QUESTIONNAIRE FOR BUTCHER SHOP OWNERS

A. BASIC INFORMATION

This section is confidential.

1. Fill in the table below Code

Name of butcher shop

Owner

Address

Code

Tel. No.: Code V_1 1-4

2. How long have you been conducting the business of running a butcher shop?

Years	Months

V_2 4-6

3. Which of these best describes your level of formal education attained?

1	2	3	4
None	Primary	Secondary	Tertiary (Specify)

V_3 ☐☐ 7-10

4. Have you received some form of training in meat handling?

1	2
Yes	No

V_4 ☐☐ 11-12

5. If yes was your answer to the above question, which of the following best describes your level of skills of training as a butcher.

1	2	3
Formal course	Informal training	None

V_5 ☐☐ 13-15

6. Name of course and date completed

Name	Date	Code

v_6 ☐☐ 16-17

7. Which of these best describes your level of understanding of hygiene?

1	2	3	4	5
Excellent	Good	Fair	Poor	None can't rate myself

V_7 ☐☐ 18

8. Is your business premises connected to the main electricity supply?

1	2
Yes	No

V_8 ☐☐ 19

9. If no your answer to the question above, what sources of power do you use?

Generator (1)	Gas (2)	Solar (3)	Other (specify) (4)

v_9 ☐☐ 20-23

10. Which of these cooling systems do you use?

Cold rooms (1)	Home refrigerator (2)	Deep freezer (3)	None (4)

v_{10} | | | 23-26

11. If your answer was no, in the above question describe briefly the methods you use to keep meat from getting rotten.

v_{11} | | | 27

12. Indicate the type of toilets on your premises

Pit latrine (1)	Water system (2)	None (3)

v_{12} ☐☐ 28-30

13. What is the main water source for your business?

Municipal water supply (1)	Bore hole (2)	Surface water (3)

V_{13} ☐☐ 31-33

14. Is water that is used in the butcher ever tested?

1	2	3
Yes	No	Don't know

v_{14} ☐☐ 34-36

15. Tick off the things that apply in your case

v_{15} ☐☐ 37

	Y	N
Foot bath at the back door to the butchery		
Washing basin available at the entrance to the butchery		
Toilets are fitted with wash basin		
Changing room is available for workers to change from their street clothes		
Workers are provided with clean white overalls, gumboots, aprons, hairnets and hats.		
Spot inspections are regularly done to assess level of personal hygiene of workers		
Employees are required to wear hair nets when		

in the butchery		
Workers are taken for medical check ups every 6 months		
Walls and floors imperious and cleaned regularly		
All blood, meat and biological waste is removed during processing		

B. TYPE AND ORIGIN OF ANIMALS AND MEAT SOLD IN BUSINESS

CODE ☐

16. Where animals are obtained from each category

Buy locally	Own animals	Buy from RSA	Others

V_{16} ☐☐ 38

17. If from RSA how do you transport the animals for slaughter?

Special trucks	On foot	Own vehicle or trailer	Others (Specify)

V_{17} ☐☐ 39

18. How frequently do you slaughter

Daily	Weekly	Monthly	On demand

V_{18} ☐☐ 40

19. How may animals do you slaughter? Fill in the table below where applies to you.

Slaughter	**Daily**	**Weekly**	**Monthly**		
Cattle				V_{19} ☐☐	41-44
Sheep				V_{20} ☐☐	
Goats				V_{21} ☐☐	
Pigs				V_{22} ☐☐	

20. Where are these animals slaughtered?

At home (1)	Business premises (2)	Slaughter slab (3)

V_{23} [ ][ ] 45

21. Are animals stunned before slaughter?

1	2	3
Yes	No	Do not know

V_{24} [ ][ ] 46

CODE ☐

22. How are slaughtered animals bled?

While lying on the ground (1)		While hanging (2)		V_{25}		47

23. How is slaughter animal skinned?

While lying on the ground (1)		While hanging (2)		V_{26}		48

24. After slaughter which of these best describes the way meat is handled

Placed on plastic sheets on the floor (1)	V_{27}	49-53
Wrapped in the skin of the slaughtered animal and carried to butcher (2)	V_{28}	
Hang in the cold room (3)	V_{29}	
Cut up and transported in crates (4)	V_{30}	
Others (Specify) (5)	V_{31}	

25. Do you have access to services of a meat inspector/examiner?

1	2			
Yes	No	V_{32}		54

26. What best describes the reason for you not having the services of meat inspectors?

_____

Government does not provide meat inspection services (1)	V_{33}	55-59
I don't think it is important increases my overhead cost (2)	V_{34}	
I don't know its importance (3)	V_{35}	
Others (Specify) (4)	V_{36}	

27. If meat is imported from RSA what is the origin

1	2	3	4	5		
Abattoirs	Farmers	Supermarkets	Wholesalers	Others (Specify)	V_{37}	60

28. How is meat transported?

Refrigerated trucks	Own vehicle or trailer	Others (Specify)		
			V_{38}	61

C. PERSONAL HYGIENE

CODE

29. Who slaughter the animals?

Hired slaughterers	Slaughter slab	Own people		
			V_{39}	62

30. How often do they clean their hands and /or knives during slaughter?

Occasionally	Frequently	At start and at finishing	Only when required

V_{40} V_{41} V_{42} 63-66

31. How are hands cleaned?

Running water	Washing basin	Rags

V_{43} V_{44} 67-68

32. Do they wash the carcass after slaughter?

1	2
Yes	No

V_{45} 69

33. If yes, where does the water come from to wash carcases?

Borehole (1)	Municipal (2)	Springs(3)	River (4)	Other (5)

V_{46} 70

34. Is protective clothing used during slaughter

1	2
Yes	No

V_{47} ☐☐ 71

35. If no, what do they use?

Own clothing	Sacks/plastics to cover own clothing	Others (Specify)

V_{48} ☐☐ 72

36. How often are slaughters taken to medical check ups?

Once in a year	Twice in a year	When sick	Not at all	Others (specify)

V_{49} ☐☐ 73

ANNEX B: RESULTS FOR TESTS PREFORMED AT VET LAB BLOEMFONTEIN

Specimen Id	Specimen type	Test	Result (-3 dilution)	Comment
A1 HQ SW	SWAB	BACT.COUNT	63000	NEG E.COLI/SALM POS FUNGI
A4 FQ O	SWAB	BACT.COUNT	2000	NEG E.COLI/SALM POS FUNGI
A4 HQ B	SWAB	BACT.COUNT	TMTC	NEG E.COLI/SALM POS FUNGI
A4 FQ S	SWAB	BACT.COUNT	TMTC	NEG E.COLI/SALM POS FUNGI
A4 ST O	SWAB	BACT.COUNT	26000	NEG E.COLI/SALM POS FUNGI
A2 FQ B	SWAB	BACT.COUNT	TMTC	NEG E.COLI/SALM POS FUNGI
A3 N O	SWAB	BACT.COUNT	TMTC	NEG E.COLI/SALM POS FUNGI
A1 SW FQ	SWAB	BACT.COUNT	TMTC	NEG E.COLI/SALM POS FUNGI
A3 FQ B	SWAB	BACT.COUNT	TMTC	NEG E.COLI/SALM POS FUNGI
A3 HQ B	SWAB	BACT.COUNT	TMTC	NEG E.COLI/SALM POS FUNGI
A3 FQ O	SWAB	BACT.COUNT	2000	NEG E.COLI/SALM POS FUNGI
A3 FQ B	SWAB	BACT.COUNT	TMTC	NEG E.COLI/SALM POS FUNGI
A1	WATER	BACT.COUNT	TMTC	NEG E.COLI/SALM POS FUNGI
A2	WATER	BACT.COUNT	TMTC	NEG E.COLI/SALM POS FUNGI

Batch 1 : Date of tests preformed:17/8/2007

Specimen Id	Specimen type	Test	Result (-3 dilution)	Comment
D1 B	OTHER	BACT.COUNT	1920000	
D2 B	OTHER	BACT.COUNT	TMTC	
D3 O	OTHER	BACT.COUNT	5410000	
D4 B	OTHER	BACT.COUNT	70000	
C1 B	OTHER	BACT.COUNT	3700000	
C2 B	OTHER	BACT.COUNT	8400000	
C1 OV	OTHER	BACT.COUNT	TMTC	
C 2 B	OTHER	BACT.COUNT	TMTC	E.COLI PRESENT
C1 B(1)	OTHER	BACT.COUNT	TMTC	E.COLI PRESENT
C4 B	OTHER	BACT.COUNT	TMTC	
D1 B	OTHER	BACT.COUNT	2340000	
C1 B(2)	OTHER	BACT.COUNT	TMTC	
D2 B	OTHER	BACT.COUNT	TMTC	
C2 SV POR	OTHER	BACT.COUNT	TMTC	E.COLI PRESENT
D1 POR	OTHER	BACT.COUNT	TMTC	
C1 OV	OTHER	BACT.COUNT	TMTC	E.COLI PRESENT
O SHOPRITE CONTROL	OTHER	BACT.COUNT	TMTC	
C B SHOPRITE B	OTHER	BACT.COUNT	TMTC	
D3 B	OTHER	BACT.COUNT	TMTC	E.COLI PRESENT
D2 OV	OTHER	BACT.COUNT	TMTC	
D4 B	OTHER	BACT.COUNT	TMTC	

D1 OV	OTHER	BACT.COUNT	TMTC	E.COLI PRESENT
Batch 2 : Date of tests preformed:22/8/2007				

Specimen Id	**Specimen type**	**Test**	**Result (-3 dilution)**	**Comment**
POR	SWA	BACT.COUNT	TMTC	
O1	SWA	BACT.COUNT	TMTC	E.COLI POSITIVE
E2 B1	SWA	BACT.COUNT	TMTC	E.COLI POSITIVE
E3 B	SWA	BACT.COUNT	TMTC	
O2	SWA	BACT.COUNT	TMTC	
OV F1	SWA	BACT.COUNT	TMTC	
OV F3	SWA	BACT.COUNT	TMTC	
F2 B	SWA	BACT.COUNT	TMTC	E.COLI POSITIVE
F1B	SWA	BACT.COUNT	TMTC	
E1B	SWA	BACT.COUNT	TMTC	E.COLI POSITIVE
E3	WATER	BACT.COUNT	20000	
Batch 3 : Date of tests preformed:10/9/2007				
Specimen Id	**Specimen type**	**Test**	**Result (-3 dilution)**	**Comment**
B1	WATER	BACT.COUNT	10000 CFU	
B4	WATER	BACT.COUNT	650000 CFU	FUNGI
B5	WATER	BACT.COUNT	0 CFU	
B3	WATER	BACT.COUNT	0 CFU	
B1 B	SWA	BACT.COUNT	10000 CFU	
B2 B	SWA	BACT.COUNT	520000 CFU	
B4OV	SWA	BACT.COUNT	680000 CFU	
B2POC	SWA	BACT.COUNT	TMTC	
B2B	SWA	BACT.COUNT	TMTC	
B4B	SWA	BACT.COUNT	4400000 CFU	
B3B	SWA	BACT.COUNT	2880000 CFU	
G2B	SWA	BACT.COUNT	TMTC	
G1B	SWA	BACT.COUNT	TMTC	
G3D	SWA	BACT.COUNT	2980000 CFU	FUNGI
Batch 4 : date of tests preformed…./9/2007				
Specimen Id	**Specimen type**	**Test**	**Result (-3 dilution)**	**Comment**
J2B	SWA	BACT.COUNT	170000	FUNGI
J1	WATER	BACT.COUNT	TFTC	
K3B	SWA	BACT.COUNT	50000	
K1B	SWA	BACT.COUNT	60000	
K1	WATER	BACT.COUNT	TFTC	
K2B	SWA	BACT.COUNT	7800000	
K2B	SWA	BACT.COUNT	40000	
K3	WATER	BACT.COUNT	TFTC	

J3POR	SWA	BACT.COUNT	520000	
Batch 5: Date of tests preformed ….10/9/2007				
H1	SWA	BACT.COUNT	260000	
H2	SWA	BACT.COUNT	TFTC	30 000; FUNGI
H3	SWA	BACT.COUNT	TMTC	E.COLI
H1	WATER	BACT.COUNT	TFTC	<10 000 CFU; FUNGI
Batch 6: Date of tests preformed…..25/9/2007				

Specimen Id	**Specimen type**	**Test**	**Result (-3 dilution)**	**Comment**
A2 B	SWA	BACT.COUNT	TMTC	Positive S.aureus
A2 P	SWA	BACT.COUNT	TMTC	Positive S.aureus
A3 B	SWA	BACT.COUNT	TMTC	Positive S.aureus
A4 B	SWA	BACT.COUNT	TMTC	Positive S.aureus
A5 B	SWA	BACT.COUNT	TMTC	Positive S.aureus
A5 O	SWA	BACT.COUNT	TMTC	Positive S.aureus
A6 B	SWA	BACT.COUNT	TMTC	Positive S.aureus
A6 O	SWA	BACT.COUNT	TMTC	Positive S.aureus
A7 B	SWA	BACT.COUNT	TMTC	
A7 O	SWA	BACT.COUNT	TMTC	
A8 B	SWA	BACT.COUNT	TMTC	Positive S.aureus
D1 B	SWA	BACT.COUNT	TMTC	Positive S.aureus
D2 B	SWA	BACT.COUNT	TMTC	Positive S.aureus
D2 O	SWA	BACT.COUNT	TMTC	Positive S.aureus
Batch 7: Date of test performed….20/12/2007				

Ladybrand Shoprite

Specimen Id	**Specimen type**	**Test**	**Result (-3 dilution)**	**Gradation Point**
LB O	SWA	3	Very good	5
LB O	SWA	1	Very good	5
LB O	SWA	5	Very good	5
LB O	SWA	5	Very good	5
LB B	SWA	0	Very good	5
LB B	SWA	0	Very good	5
LB P	SWA	1	Very good	5
LB B	SWA	0	Very good	5
LB B	SWA	0	Very good	5
LB B	SWA	0	Very good	5
LB B	SWA	0	Very good	5
LB B	SWA	0	Very good	5

LB P	SWA	1	Very good	5
LB P	SWA	1	Very good	5
LB P	SWA	1	Very good	5
Batch 7: Date of test performed…14/10/2008				

Key:

SWA: Swab

TMTC: too many to count

TFTC: too few to count

ANNEX C: DISTRICT ID NUMBER AND BUTCHER SHOP ID NUMBER

District ID		**Butcher shop ID**	
Maseru	A	Monono	A1
		S M	A2
		Buti	A3
		Tip Top	A4
		Benzons	A8
		Check out	A5
		Hillside	A6
		Machache	A9
		Shoprite Sefika	A7 A
		Shoprite LNDC	A7 B
Leribe	C	Kopanang Basotho	C1
		Standard	C2
		Kopanang ii	C3
		Shoprite	C4
Berea	D	TY meat Suppliers	D1
		Roadside	D2
		Taung	D3
		Holy Cross	D4
Mafeteng	E	Standard	E1
		Farm Fresh	E2
		Shoprite	E3
Butha- buthe	B	Welcome	B1
		Elangeni	B2
		Machabeng	B3
		Litsoakotleng	B4
		Bakuena	B5

Mohales'hoek	F	Mafoso Fresh Meat	F1
		Edma	F2
		KBT	F3
		MK	F4
Quthing	G	Frazers	G 1
		Sehlekehleke	G2
		Liphakoe	G3
Mokhotlong	J	Thialala	J
		Tsoana makhulo	J
		Phokeng	J
		Farm products	J
Thaba tseka	K	Star	K4
		Lilala	K1
		Mamaroala	K2
		Slaughter slab	K3
Qachas'nek	H	City	H1
		Bataung	H2
		Likepolane	H3
		Qachas'nek	H4
RSA	LB	Ladybrand Shoprite	LB S