CAMEL BRUCELLOSIS: SERO-PREVALENCE AND PATHOLOGICAL LESIONS AT SLAUGHTERHOUSES IN GARISSA COUNTY, KENYA

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J56/7489/2017

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE OF UNIVERSITY OF NAIROBI (VETERINARY PATHOLOGY AND DIAGNOSTICS)

DEPARTMENT OF VETERINARY PATHOLOGY, MICROBIOLOGY AND PARASITOLOGY

FACULTY OF VETERINARY MEDICINE

UNIVERSITY OF NAIROBI

2020

DECLARATION

This thesis is my original work and has not been presented for award of degree in any other University or institute of higher learning.

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DEDICATION

To My lovely Mom Aisha Abdurrahman Mohamed May Allah give her health, my father Dahir Barre who passed-on in 2006, I wish Allah give Jana, My Mom Marian Sheikh Doon and my Lovely Mom Ruqiya Issa Ahmed Ulusow with her family, and also My second Fathers Moalim Ahmed Moalim Abdulla and Awowe Abdirahaman Affi Abdalla.

ACKNOWLEDGEMENT

I would like to acknowledge and glorify my almighty Allah who gave me strength, knowledge and blessing during all my academic studies. I am gratefully indebted to my supervisors, Dr. Davis. N. Karanja and Prof. Lilly C. Bebora for their professional guidance, valuable suggestions, constructive criticism and other corrections that they took throughout this work.

Much appreciation goes to the University of Nairobi through Department of Veterinary Pathology, Microbiology and Parasitology (VPMP), through the Chairman Prof. Samuel Githigia, through the staffs of the Department Ann Munene, Charity Gathenya, George Dimbu, late Jane Gachigua, Lydia Maina David Mureithi and Grace Mwangi in Histopathology section and Bacteriology section for their assistance in the course of this work. Sincere appreciation goes to other staff members particularly: Prof. Paul. G Mbuthia, Prof. Peter. K Gathumbi, Dr.J. K Gathumbi, Dr. Lucy W. Njagi, Dr. Mahacla O.Odongo, and Dr. Robert.M Waruiru who were always encouraging me and giving me advices during my master degree training.

My sincere thanks go to the staff of Department of Public Health, Pharmacology and Toxicology especially in immunology section Dr. Gitahi Nduhiu, Mr. Alfred O. Mainga and Mrs Penina Ateku and Macharia J.K. for their assistance in sample processing and preparation. Addition gratitude also goes to Prof. George Gitao who had faith in me and gave me support throughout this study. I am very grateful to my classmates who were always there for me encouraging me especially Dr. Wanja Daniel, Dr. Peninah Wamboi, Dr. Erick Titus Mosha, Dr. Acsa Igizeneza God bless you all.

I am very thankful to the Kenya Camel Association Director, Mr Kahlif Abdirahman Abey who give me the opportunity to further my studies until I finished the research project by sponsoring me financially. With a great pleasure, I am also acknowledging to this work my

lovely Grand Fathers Abdurrahman A'afi Abdulla, Abdinasir A'afi Abdulla and Mohamed Abdurrahman Mohamed with the outstanding, unwavering support, encouragement and inspiration in my academic and professional endeavours to me day and night during my study

Lastly, I want to thank my brothers and sisters: Mohamed, Abdirisaq and his wife Fardowsa Salad and her kids (Mohamed, Farhiya, Najma, Abdurrahman, Abdulahi Abdi Shakur, Abdifitah (has pasted-on my Allah give him Janna) Hassan and Hussein, Ahmed Zahra, Asma, Sumaya (has pasted- on), saabiriin Anab Dahir Barre and all family members of Dahir Barre Jim' ale, for all that I am and all I will ever be, I owe it to you.

LIST OF ABBREVIATIONS AND ACRONYMS

AGID-T	:	Agar Gel Immuno-Diffusion Test
B.abortus	:	*Brucela abortus*
B.melitensis	:	*Brucela melitensis*
BA	:	Blood Ager
C-ELISA	:	Competitive Enzyme Linked Immuno sorbent Assay
CFT	:	Complement Fixation Test
CDC	:	Center of Disease Control and Prevention
^{o}C	:	Celsius of Degree
CCO	:	County Commission Officer
DVSC	:	Different Vaccinated Slaughtered Camel
CDPO	:	County Development Planing Officer
DVO	:	District Veterinary Office
DA	:	Dadaab
DPX	:	DibutylPhthalate Xylene
FAO	:	Food and Agricultural Organization of United Nation
FMBAH	:	Field Manual Basis in Animal Health
GCK	:	Garissa County Kenya
GT	:	Garisa-Township

H&E	:	Haematoxylin and Eosin stain
Ho	:	Null Hypothesis
KNBS	:	Kenya National Bureau of Statistics
NaCl	:	Sodium Chloride
OWCs	:	Old World camels
OIE	:	World Organization for Animal Health
OD	:	Optical Density
OPD	:	Ortho-Phenylene Diamine
RBPT	:	Rose Bengal Plate Test
SAT	:	Serum Agglutination Test
Sp	:	Specificity
Se	:	Sensitivity
SP	:	Standard Protocol
µl	:	Microliter
VPMP	:	Veterinary Pathology Microbilogy and Parasitology
+Ve	:	Positive
-Ve	:	Negative
WHO	:	World Health Organization
X^2	:	Chisqure

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ABSTRACT

Camel brucellosis is an infectious disease, mostly presenting in chronic state; caused by Brucella organisms, which also affect other animals including man. There is little information in Kenya on the prevalence of the disease in camels to inform need for prevention and control measures. This study aimed at determining the presence of the disease in slaughtered camels in Garissa County through serological testing and pathological lesions encountered at meat inspection. Three sub-counties: Garissa Central (represented by Garissa Township), Garissa East (represented by Dadaab) and Garissa West (represented by Balambale) were purposefully and randomly selected based on presence of camel slaughterhouses and accessibility. One hundred and sixty camels were selected from 238 brought to the slaughterhouse during the visits based on the clinical manifestations suggestive of brucellosis observed on ante-mortem examination and clinical history obtained from the owners of the animals. The three main clinical signs that suggested brucellosis were lameness, swollen lymph nodes and history of abortion. Seroprevalence determination involved blood collection from the jugular vein and screening the serum for presence of *Brucella* antibodies using Rose Bengal Plate Test ,Serum Agglutination Test, Competitive- Enzyme Linked Immuno Sorbent Assay and Agar Gel Immuno-diffusion Test. The selected 160 test camels, were followed into the slaughterhouse, where respective condemned organs were further examined grossly and microscopically recording the observed changes. It is, however, noted that the observed changes are not pathognomonic for brucellosis; they can also be due to other disease(s).

Out of the 160 camels tested, 15 (9.37%) were positive for *Brucella* antibodies; including 4/50 (8%) in Garissa Township; 5/50 (10%) in Dadaab and 6/60 (10%) in Balambale. Using chi-square statistics the sensitivity of the four serological tests were not significantly different ($p=0.999$).

Seventy eight (48.7%) camels had one or more condemned organs at meat inspection. The common gross lesions encountered were fibrin depositions 3 (1.8%), enlargement of lung 2 (1.2%), pericarditis 38 (23.7%), and hepatomegaly with nodular liver lesions 79 (49.3%), enteritis 5 (3.1%), haemorrhages and congestion of visceral organs (lung and kidney) 6 (3.7%). Histopathological pictures included: cellular infiltration in lymph node 9 (5.6%), hypoplasia of lymphocytes 6 (3.7%), collapse of alveoli 5 (3.1%), oedema, congestion 4 (2.5%), fatty degeneration in liver 3 (1.8%) and haemorrhages in kidney1 (0.6%). In conclusion, this study showed that brucellosis is prevalent in camels in Garissa County. However, further research should be done in the whole country. Since the four tests were not significantly different, with respect to picking positive cases, RBPT is recommended as a screening test, since it is cheap, quick, and easy to carry-out. The other three can be used to establish respective antibody titres. Standard biosecurity measures at slaughterhouses and farms needed to be enhanced for the control and prevention of *Brucella* infection to animals and human.

CHAPTER ONE: INTRODUCTION

Camel is an adaptable animal and has been domesticated by man. It offers the quickest mode of transport in deserts thus it is referred to as the ship of desert (El-Bahrawy, *et.al,* 2015). It is also used for economic and social aspects; camels are used for milk and meat, also as for different functions like transport, amusement, celebration and competition as in athletics (Kaskous, 2016).

Camels (*Camelus dromedarius*) are most important livestock in North-Eastern province, they offer nourishment to the residents, particularly during the time of the frequent droughts when different animals either die or are unthrifty (Wanjohi, *et.al,* 2012). This is because they are resistant to the extreme weather of semi-desert, arid and semi-arid areas. Camel populace in Kenya is more than 1 million and about 54% of them are kept in Garissa and Wajir counties (Kenya National Bureau of Statistics, 2009). Occupants of these are very dry regions are for the most part of Somali root and are pastoralists.

Globally, camels are important industrially and financially. According to Food and Agriculture Organization of the United Nations and (Sprague, *et.al,* 2012), there are about 600,000 camels in Kenya. Almost of all them being kept by migrant pastoralists in the arid lowlands of Northern Kenya. Camel brucellosis has been documented for in all camel-raising nations. Rearing for spread being the uncontrolled exchange of live animals. (Kang'ethe, *et.al,* 2000)

In Kenya, there are three sorts/types of camel: Turkana type which is small in size; averaging 350 kg, Rendille/Gabbra type which three hundred 300 kg and Somali type which is size, estimated to weight 550 kg. The camels are utilized as multifunctional animals and their numbers are set to rise in the future (Gwida, *et.al,* 2012).

They are great milk makers for delivering to the other counties like Nairobi and Isiolo County, for more milk contrasted and dairy cattle and small stock. They, accordingly, prove

to be useful especially during, the dry season; the pastoralists incline toward camel drain to that of other domesticated animals' creatures as a result of its delectable taste and its being nutritious (Kaindi, *et al*, 2011).

About 60% of Garissa County population are pastoralists who keep around 300,000 camels; contributing towards economy growth of the County (Garcell, *et.al,* 2016).

Brucellosis is a zoonotic disease of animals and human. The main source of infection is animal; man getting infected through consumption of unboiled milk and uncooked meats such as liver and kidneys from infected animal; also through close contact (for example when slaughtering) and through breathing (Moreno, 2014; and Musallam, *et.al,* 2016).

The disease is caused by bacteria of genus *Brucella*; The two (2) mostly affecting camel are *Brucella melitensis* and *Brucella abortus* (Musa, *et.al,* 2008). In terms of camel production systems, it has been shown that the *brucella* sero-prevalence is higher in intensive camel rearing farms then in extensive rearing farms (Abbas, and Agab, 2002). The disease spreads from herd to herd or from animal to animal; also from country to country (Fatima, *et.al*, 2016).

The disease is of economic importance since the infected animals will experience reduced milk production and, since the disease affects internal organs, the affected organs may be condemned at slaughter. There is documentation of respective condemned organs (visceral organs) in camel slaughterhouses worldwide (Esmaeili, *et al*, 2016).Thus the organ condemnations have commercial and public health significance; they are associated with direct economic losses (Assenga, *et.al,* 2015).Therefore, the condition that may leading to organ condemnation in camel slaughtered are bacterial and parasitic infections agents and non in factious organism can be cause organ condemnation in terms of transmission (Megersa, *et.al,* 2011).

1.1: Hypotheses

- There is high prevalence of camel brucellosis in Garissa County
- Some of the organs condemned at camel slaughterhouses are as a result of brucellosis.

1.2: Objectives

Overall objective of the study is to establish sero-prevalence of camel brucellosis in Garissa County, Kenya, and document respective condemned organs at slaughter

Specific objectives

1. To determine sero-prevalence of brucellosis in camels slaughtered of Garissa County
2. To examine respective condemned organs and document gross and microscopic pathological lesions

1.3: Justification

Camel is the dominant livestock in North-Eastern province where it provides sustenance to many people (many pastoralists) especially during the frequent droughts when other animals either die or are unthrifty. This is because the camel is highly suited for hot desert, semi-desert, arid and semi-arid areas. The pastoralists use camels for milk and meat production, transport, as draft animals. Thus, camel plays a major role in socio-economic well-being of these people; it contributes about 80% of the household food needs (Sayour, *et.al,* 2015; Shahzad, *et.al,* 2017).

However, for a long time, camels have been given little attention, in terms of improvement programs, compared with other domesticated animals. It is only in recent years that there has been some sort of consideration on the camel; Camel milk is now sold in all major cities in Kenya; and it is hoped that, in future, importance of the camel will soar. Just like other

animals, diseases are a major cause of production reduction in camels, thus leading to economic loss (Mohammed, *et.al*, 2011).

One such disease, which is also zoonotic, is brucellosis; camels being infected by the same *Brucella* species that affect cattle and goats, hence they are at risk of being infected when raised together with cattle and goats. Animals become infected through consumption of contaminated feed, water, colostrum and, particularly, by licking or breathing at placentas and aborted foetuses (Sprague, *et.al*, 2012); There is also risk of the farmers, slaughterhouse workers, butchers and consumers of camel meat getting infected. Due to the little attention given to camel production *vis a vis* cattle production, there are no brucella diagnostic processes particularly customised for the camel (Gwida, *et.al*, 2012). All brucella serological tests and pathological lesions/examinations are pegged on those meant for the cattle. Since it is projected that soon camel-keeping will be as important as cattle-keeping country-wide, it is important to customise diagnostic processes to the camel. This study has attempted to do that; it has also put emphasis on examination of pathological lesions (grossly and histopathology) as an alternative diagnostic process for brucellosis. Since the disease results in organ condemnations at slaughter, examination of the condemned organs will give easily-available data which can be used for establishing possible presence of the disease in respective farms; no such study has been done before (Kumar, 2013).

The confirmatory diagnosis of the *Brucella* disease in camel; including demonstration of brucella-like lesions in condemned organs, and knowledge about its prevalence, it is very important for disease-control purposes for the study area, Garissa County (part of North-Eastern Province), and Kenya as a whole. (Wareth, *et.al*, 2014).

CHAPTER TWO: LITERATURE REVIEW

2.1: General information on camels

The camels is an even-toed ungulate animal that is found in arid and semi-arid lands (ASALs). It is huge in size with an extended and long neck, long legs and one or two humps on its back. It has which are well-structured to travel quickly in deserts and natural diversifications that allows to survive for long with-out food and water (Sprague *et.al*, 2012).

Camel is a domestic animal and also a source of food and textile when kept as livestock. Camel belongs to a diverse group of animals called ungulates (hoofed mammals). Camellias are members of the biological family Camelidae: camelids are classified in the suborder Tylopoda (pad-footed animals) that represents with the suborders Suiformes (pig-like) and Ruminantia (ruminants) the order Artiodactyla (even-toed ungulates) (Kabir and Dey, 2012).

The camels are also important in socio-economic significance in many parts of the Africa and milk constitutes of camel are an important constituent for mankind diets in daily (Yadav *et.al*, 2015). Camels are the most proficient animal species in persistence and production under tough environmental conditions in marginal arid areas (Patodkar, *et.al*, 2010; Rathinasabapathy and Rajendran, 2015). And also camels are well adapted to the climatic extremes and are well appreciated for their significance in the pastoral economy (Racloz, *et.al*, 2013).

The Camel plays an important role in socio-economics within the rural and agricultural co-ordination in dry and semi dry zones. It has a distinctive quality which make it superior to the other domesticated animals in the hot and arid desert ecosystems where they contribute to the desertification combat and food security (Faraz, *et.al*, 2013). They serves as a cheap source of power for drawing water from wells, ploughing and levelling of land, working mini mills for oil extraction (from oil seeds), grinding wheat, corn and other grains and for crushing

sugarcane, and pulling carts for the transportation of goods as well as people (Yaqoob and Nawaz, 2007).

2.2: Types and Importance of camel in Kenya

There are more than two million of dromedary sorts of camels in Kenya; most of which are found in North-Eastern part of Kenya nation. However, for a long time camels have been given little attention, in terms of improvement programs, compared with the other animals. It is only recent years that there has been some sort of consideration on the camel. The essential purposes behind keeping camels differ from nation to nation and from one place to the next (Anderson**,** *et.al,* 2012).

The camels are used mostly for milk generation and transport purposes; also as draft animals (Ahmad, *et.al,* 2010). They contribute towards daily diet (meat and milk) and financial prosperity of the keepers. Camel keeping contributes about 80% of family unit sustenance needs (Ahmad, *et.al,* 2007 and Konuspayeva, *et.al,* 2009).

Camels are utilized for local transport; they deliver drain for on-farm utilization; and enhance the proprietors' monetary status through animal slaughter. At present camel meat is not popular in Kenya, while there is higher demand for butchered camels in the Arabian Peninsula (Abo-Elnaga and Osman, 2012). All camels in Kenya belong to the type which is normally referred to as dromedary or "one-bumped camel". There are no standard breeds in Garissa County; Types that are mostly reared are Somali type, which is generally light-coloured, tall (bear tallness fluctuates from 1-95 to 2-2 meters in adult females) with long tight bodies and small mounds. The other one is Rendille-Gabbra type, named after the peaceful clans which keep them. Rendille/Gabra camels differ in shading from dull dark to white. They are a smaller (bear stature somewhere in the range of 1.70 and 1-85 meters), have short profound bodies and exceptionally articulated protuberances when pastures are

satisfactory. Rendille/Gabra are found predominantly in the Northern and North-Western parts of the Garissa County (Agab**,** 2006).

2.3: Major Causes of organ condemnation at camel slaughterhouses

Organ condemnations at slaughter account to major economic losses for farmers; they also have public health significance (Chakiso, *et al,* 2014; Tembo and Nonga, 2015). Conditions leading to condemnation of organs in slaughtered camel have been documented around the world. The major causes of camel organ condemnation include: hydatidosis, pneumonia, emphysema, calcification, cirrhosis, fasciolosis, splenomegaly, oedema, nephritis, cysticercosis, haemorrhage, and swollen lymph nodes with abscess. (Hamza, *et.al,* 2017).

In Iran, Khaniki *et.al* 2013 demonstrated that most causes of organ condemnations were parasitic infections for the condemned livers the causes were *Fasciola* spp., *Dicrocoelium* and hydatid cysts (Khaniki *et.al*, 2013).

In (2013) Saudi Arabia, out of total 385 camels slaughtered, 230 (59.74%) lungs, 34 (8.83%) livers, and 6 (1.55%) hearts were condemned (Mohamed, *et.al* 2014). In Ethiopia, the condemned organs were due to fasciolosis in liver (12 %) and cystic hydatidosis in lung were (14%); *Corynebacterium* was isolated from condemned camel heart (2%) and condemned entire carcass (0.6%). In 2015 Tanzania, the following organs were condemned (13%) lungs, (9%) intestines, (8%) livers, (10%) kidneys and (0.1%) as whole Reasons for condemnation were: pulmonary emphysema (3 %), fasciolosis (5 %), pimply gut (8 %), renal congenital cysts (2 %), hydatidosis (3 %) and tuberculosis (0.01%) (Tembo and Nonga, 2015; Calderón, *et.al,* 2010).

Finally, in Kenya, 2009 and 2010 a retroactive study in North-Eastern region reported that liver, lung and super-mammary lymph node condemnations were due to parasitic and bacterial agents (59% and 45% respectively).

2.4: Camel Brucellosis

Brucellosis is an incessant infectious disease brought about by bacteria of genus *Brucella*. It is one of the world's most important zoonosis. The disease effects both domestic and wild animals, including: sheep, goat dairy cattle, camel, pig, deer, hound, and etc. (Khamesipour, *et.al*, 2015; Meles, Y., and Kibeb, L. 2018). It is also a zoonosis; humans getting infected through eating or drinking uncooked meat or milk from the infected animal (Calderón *et.al*, 2010; Chauhan, *et.al*, 2017).

In camels, the disease manifests as premature birth, retained placenta, orchitis, and sterility. There is also fever muscle pain and neurological disorder (Njeru, *et.al*, 2016). Camels are susceptible to brucellosis brought about by *Brucella abortus* and *Brucella melitensis* (Tilahun, *et.al*, 2013; Abbady, *et.al*, 2012).

2.4.1: Biology of *Brucella* Bacteria

Brucella organism are gram-negative, *coccobacillary*, non-spore forming and non-motile. They are facultative intracellular; meaning, they localize and proliferate within the cytoplasm of monocyte and reticular-endothelial cells (Wang, *et.al*, 2014); thus are protected from the host defence mechanism. They are aerobic except for *B. abortus* which requires 5% to 10% of carbon dioxide (Co_2) on initial isolation. The organisms are slow growers, taking up to 2-4 days. The optimum growth temperature is 37ºC. The genus consists up to ten species (Vila, *et.al*, 2010).

2.4.2: Antigenic Structure of brucellosis in camel

The colony surface of *Brucella* bacteria of camel; *B. abortus and B. melitensis* (Figure: 1and 2) have recognized as the lipopolysaccharide O-polysaccharide constituent that composed of a reiterating pent-saccharide unit which is comprising a sequence of one 1,3 to 4 1, 2-linked to 4,6-dideoxy-4-formamido-α-D-mannopyranosyl components (Omar, *et.al*, 2010;

Chuluunbat,, *et al.* 2014). These colony of *B.abortus and B. melitensis* have been localized and proliferated within the cytoplasm of monocyte and reticular-endothelial cells (Wang, *et al.* 2014). And they protect the host defence mechanism. *Brucella spp*. are aerobic exapt B. abortus in animals which requires 5% to 10% of carbon dioxide (Co_2) to make growth. The optimum temperature of all brucella spp. To grow in media is $37C^o$.

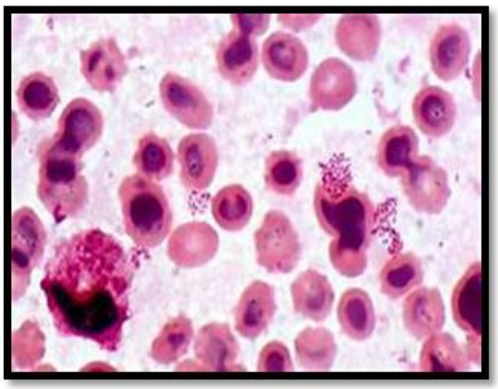


Figure 2. 1: Colony of *Brucella abortus* in camel

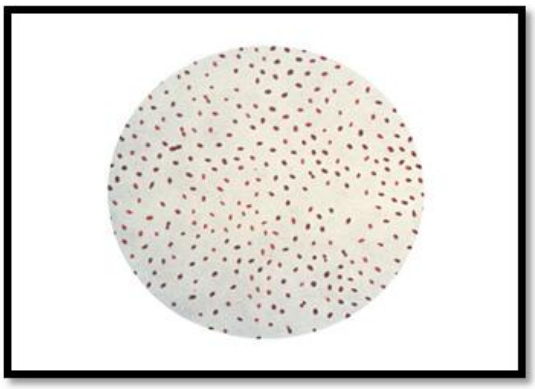


Figure 2. 2: Colony of *Brucella Melitensis*

Source: CDC Burton's Microbiology for the Health Science and histopathology (Vol.1).image liberary number 209 (Omar, *et.al*, 2010; Chuluunbat, *et al.* 2014).

2.4.3: Transmission of the Disease in camel

The two most important species of camels (*Camelus bactrianus* and *Camelus dromedaries)* are frequently infected with *Brucella bacteria*, when they are raised close to other infected ruminants like sheep, goats, and cattle. The camel gets infected through lungs, intestinal tract, mucous membranes and skin. The pathogen then travels via the blood to other organs such as liver, kidneys, lymph-nodes, spleen, or the haematopoietic system. Zoonotic *Brucella* are as given (Figure 2.1).

The most common route of often transmission is through ingestion; other are include route, venereal route, and through conjunctiva life form is most as often as possible procured by ingestion. The respiratory course, conjunctivitis and genital vaccination, skin and uterus **(**Khazaei, *et.al*, 2016).

Therefore, the most cross transmissions occurs in between cattle, sheep, goats, camels and other species (Dawood, 2008). Humans always get infected by animals; human-to-human transmission does not occur despite the fact that transmissions through breastfeeding, blood transfusion or tissue transplantation have been documented (Hadush and Pal, 2013). Humans get infected through consumption of raw milk or uncooked meat from an infected animal (Abebe**,** *et.al*, 2017), While, Animals may be infected through consumption of contaminated feed, pasture, water, milk, aborted foetus, fatal membranes, uterine fluid and discharges. Infection is also transmitted via dogs, rats, flies, boots, vehicles, milking machine and other equipment that used in the milking barn. The organism may be occasionally shed in urine (Hadush and Pal, 2013).

Since there is a chance that one may unknowingly slaughter an infected animal, care needs to be taken; a hook should be used in handling the uterus and udder (Al-Garadi, *et.al*, 2015).

It is, however, consoling to note that *Brucella* organisms have only a short life-time in the muscles of slaughtered animals; as they are destroyed by lactic acid. In man, brucellosis is called “Undulant Fever”; since the affected person tends to have intermittent high fever, headache and generalized malaise (Garcell, *et.al*, 2016). However, if high levels of hygiene and sanitation are practised, chances of humans getting infected are minimised.

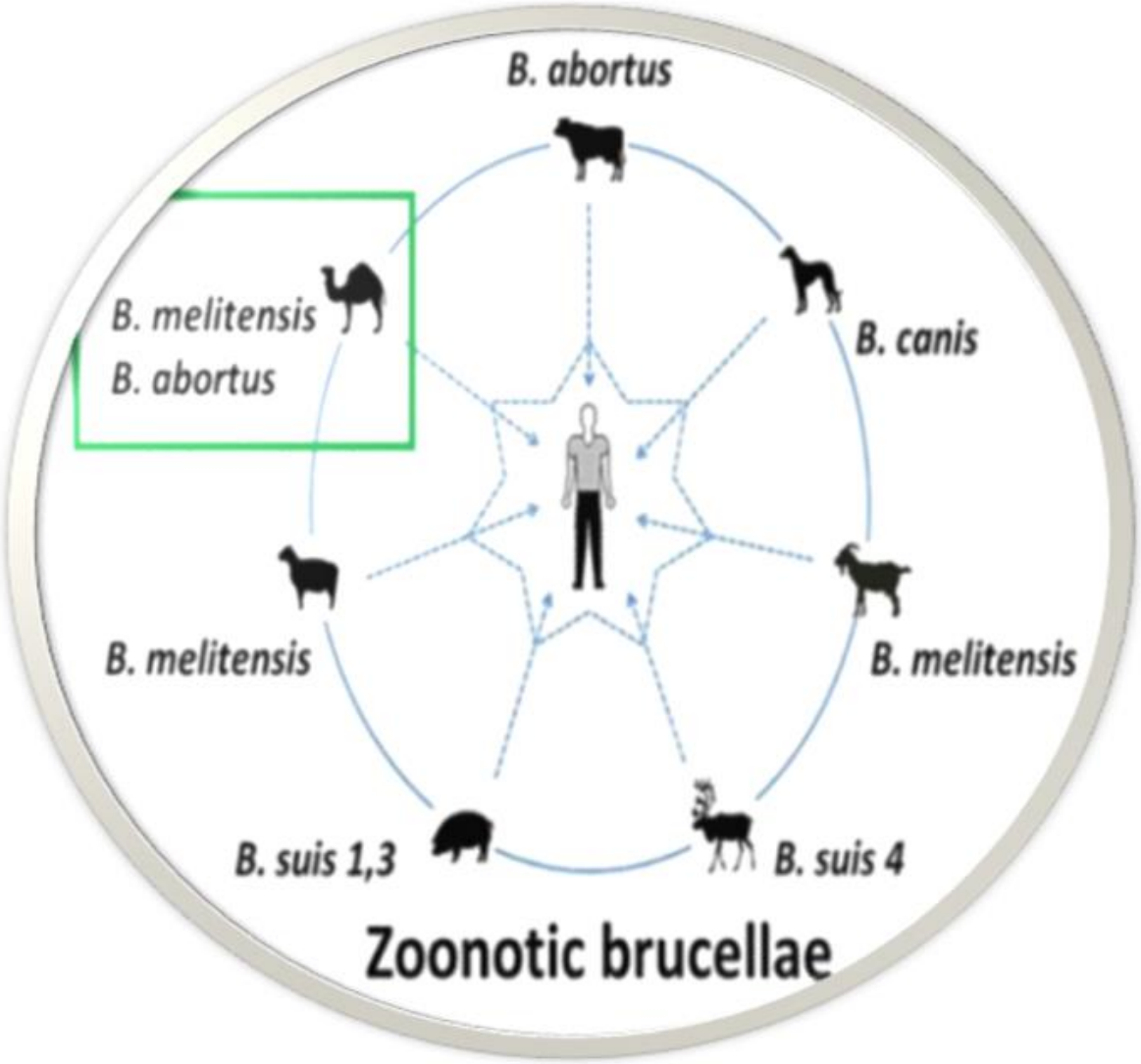


Figure 2.3: The infection cycle of the disease in camel to the human being and other species http://medwebmon.org/2014/11/page/2 visited August, 1 2018

2.4.4: Epidemiology of brucellosis

The disease has a worldwide distribution according to (OIE, 2012). it affects camel, pigs, sheep, cattle, goats, dogs and, occasionally horses. The disease has also been shown to affect wildlife species (bisons, African buffalos), and, more recently in marine mammals and others (Ghanem, *et.al.* 2009).

The contamination occurs via mucous membranes, that including oral-nasopharyngeal, conjunctiva, and genital mucosa through cutaneous abrasions. The spread of *Brucella bacteria* Spp. during sexual activity plays a secondary role to the shedding routes of *Brucella* organisms that may remain uterine fluids and placenta which expelled from infected animals (Hadush *et al*, 2013).

Brucellosis is an enzootic in specific in rural areas of developing countries and is an important occupational hazard for veterinarians, meat inspectors, farmers, animal health inspectors and butchers (Junaidu, *et.al.* 2006). There is circulation of disease-causing organisms between cattle, sheep, goats, pigs, dogs; man being a dead-end host (Gyuranecz, *et.al*, 2016).

In many developing countries such as Asia and parts of Africa, camels are still the most important livestock for nomadic populations. Therefore, countries where the disease is still prevalent are Middle East, sub-Saharan Africa, India, and China (Godfroid *et al*, 2011; Kulakov, *et.al*, 2010). Therefore, Table 2.1 indicates that the occurrence of brucellosis in camel from selected countries in Africa as reported by (OIE, 2012) is below.

Table 2.1: Countries that reported occurrence of brucellosis camel (OIE 2012 and 2015)

			Camels		
Country	Out break	Cases	No. of Death	No. Slaughtered	No. Destroyed
Algeria	367	1019	0	979	40
Congo DRC	7	375	28	173	1
Egypt	165	1129	NS	NS	NS
Ghana	3	30	16	2	0
Liberia	1	688	586	0	0
Tanzania	19	245	3	118	0
Djibouti	3	6	1	0	0
Somalia	19	111	21	9	0
Uganda	282	NS	NS	NS	NS
Kenya	1	521	NS	NS	NS

2.4.5: Clinical signs

Camels are vulnerable to brucellosis brought about by *Brucella melitensis* and *Brucella abortus* (Gessese, *et.al*, 2015; Osoro, *et.al*, 2015); Recovered animals normally become carriers; *Brucella* organisms are rated as bio risk group III by (WHO, 2011).

The two types of camels (*Camelus bactrianus* and *Camelus dromedaries*) are frequently infected with *Brucella*, particularly when they raised among infected ruminants like cows, sheep, and goats. The organisms can enter the body through lungs, intestinal tract, mucous membranes are then transported through blood to different organs, for example, the liver, spleen, or other hematopoietic system Clinical signs manifested by brucella-infected an antibody are normally mild, and including: in appetence, weakness, joint inflammation, and

lacrimation etc. (Hadush and Pal, 2013). Other manifestations may include: orchitis, epididymitis, placentitis, premature birth and sterility (Narnaware, *et.al*, 2013)

The infection of camels with *Brucella abortus* may lead to mild clinical manifestations as in appetence, minimal lameness due to arthritis, lacrimation, orchitis (meaning that inflammation of testicles) and epididymitis occurred and on the other hands *Brucella melitensis* may cause retained placenta placentitis, infections of the urogenital tract, abortion with mummification, and infertility were also observed (Hassan-Kadle, 2015).

2.4.6: Pathological lesions of Brucellosis in camel

A little is known about pathology brucellosi*s* in camel. The bacteria also have predilection for pregnant uterus, udder, testicles, accessory male sex glands, lymph nodes, joint capsules and bursa (Hosein, *et.al*, 2018). So as to in other animals' camel brucellosis would manifest as follows: fever, increased respiration and depression, inferior quality of semen in males swelling of scrotum and lymph nodes (Abo-Elnaga and Osman, 2012). In chronic stage the affected animal (camel) may show: enlarged and hardened epididymis, thickened scrotal tunics and frequently atrophic testicles, abortion and retained placenta in female (Wareth *et.al*, 2014)

At slaughter/post mortem examination, for *Brucella abortus* and *B. melitensis* the organism can be isolated from the placenta and all fatal specimens, including that the brain, small and large intestines, spleen, kidney, liver, stomach fluid, heart, lymph nodes and lung. Also, for the two species, *infected* camel show the following: –in lymph node (especially supramammary) can be seen oedema, enlargement (lymphoid hyperplasia), and granulomatous reaction in the cortical area of the lymphoid follicle. - Spleen can be seen enlargement with granular surface, granulomastitis, proliferation, and interlobular fibrosis in connective tissue. – Uterus can be seen mucous and ulceration in endometrial mucosal

membrane, oedema and diffuse and heavy infiltration, macrophages and lymphocytes in some area, dilated in blood vessels and congested (Beigh, *et.al.* 2017).

2.4.7: Diagnosis

Camels are susceptible to *Brucella melitensis* and *Brucella abortus*. Not much has been done to validate the commonly-used serological tests, with respect to camel brucellosis; this is because of the way the camel was not valued as highly as cattle and goats before. As of now, isolation and characterization of the organism, as well as the serological tests used to diagnose brucellosis in camels are carried out using the cattle protocol (Nourani, and Salimi, 2013). Hence there is need of validation for usage in camels. This study used four of the serological tests and compared their sensitivity, with respect to camel brucellosis.

2.4.7.1: Laboratory diagnosis

Isolation of *Brucella* organisms from infected organs/tissues is the definitive way of diagnosing brucellosis. However, it takes long and there have been low chances of isolating, since normally, the number of organism's present is low. Thus, serological tests, such as Rose Bengal plate test, complement fixation test, are currently preferred to demonstrate presence of respective antibodies that have shortcomings in terms of sensitivity and cross-reactions with other organisms (giving false positive reactions) (Ducrotoy, *et.al*, 2017).

For cattle, the World Organization for Animal Health (OIE) recommended usage of more than one serological tests for the determination of antibodies; in order to increase the chances of picking positive cases (WHO/FAO, 2016). It is recommended that ELISA tests, are included due to their sensitivity and specificity (Franc, *et.al*, 2018).

2.4.8: Risk factors

The disease is zoonotic and is caused by gram-negative bacteria therefore, world health organization (WHO) has categorized as risk group III. The species *Brucella abortus* and *Brucella melitensis* have been isolated from sick camels; even though clinical symptoms are generally mild in camels (Khamesipour *et.al,* 2014).

The main risk factors of *Brucellosis* in camels include: drinking unpasteurized milk, eating unpasteurized cheddar, and close relationship with the infected animals (ranchers, veterinarians) and with creature items (meat processors and meat/milk consumers). Veterinarians, agriculturists, and abattoir specialists are at high risk of being infected by the disease (Madu, *et.al,* 2016).

The disease in camel causes poor or reduced production, due to premature births, sterility, and retained placenta, stillbirth or birth of weak. This results in economic loss to the farmer (Earhart, *et.al,* 2009).

In the county, there was thirteen cases of camel brucellosis have been documented in Garissa West sub-district; however, they were associated with unspecified abortions and prolapse of uterus. Serological diagnosis was also attempted; but there is minimal documentation on this. Livestock movements are major risk factors of zoonotic disease which can easily spread from herd to herd and area to area. Therefore, controlling of animal movements within and into the county is one of the control measures that needs to be put in place (Kozukeev, *et.al,* 2006 and Al-Majali, *et.al,* 2008).

2.4.9: Differential diagnosis

Although the consistent diagnosis of *Brucella* spp. can be achieved by direct detection for affected tissue/organ condemned. The most detecting condemned tissue are including placenta and lymph nodes, liver, kidney and lung. However, to differentiate *Brucellosis* in

camel to the other disease is complicated, and constitutes a potential risk for the laboratory staff (Racloz, *et.al,* 2013).

For this reason, there are various deferential diagnosis of *Brucellosis* in camel as a fibrosis, mycoplasma infections, trichomoniasis, mycosis, nutritional, leptospirosis and physiological causes (FAO, 2010; OIE, 2013 and Racloz, *et.al,* 2013).

Those are the other suspected disease or similar disease in camel and also cattle as reported FAO; OIE and WHO in Veterinary Manual of Disease in sub Saharan Africa (WHO/FAO/OIE, 2004). Reported for the consultation on emerging zoonotic diseases.

2.4.10: Prevention and Control

Brucellosis has been eliminated in numerous areas of the world, yet in others, it is a still a big problem; especially since there is no cheap treatment available. (Khamesipour, *et.al,* 2014). Thus, eliminating the disease requires coordinated efforts at both county and country levels. People need to be made aware of the disease and how it spreads and where, available, vaccinations be carried out. As of now, the only vaccines that can be used are those for cattle and goats' *B. abortus* strain S19 and B. *melitensis* Rev 1. There is, therefore, need to customise them to the camel, for example: establish the right age to vaccinate and the vaccination regime (Yadav, *et.al,* 2015).

At the slaughterhouse, in order to prevent and control the spread of brucellosis in camels and other animal species. The carcasses infected with brucellosis are permitted to remove the affected parts, as *Brucella* bacteria remain for a short period in the muscle after slaughter (World Health Organization. 2006; Warsame, and Grothey, 2012).

Eradication of brucellosis in animals involves "test and slaughter" policy (where sero-positive animals are destroyed –incarnated) or to a lesser extent testing and separating of

positive reactors, isolating, zoning, and continuous monitoring (Warsame, and Grothey, 2012).

So, for the control programs to succeed, the area of infection must be located; the infection must be contained and, where possible, infected animals be eliminated. There is, however, constrains to the 'test and slaughter' exercise as a few infected young animals may remain serologically negative to standard test until late into the first pregnancy (Keskes, *et.al*, 2013).

CHAPTER THREE: MATERIALS AND METHODS

3.1: Study area

This study was carried out in Garissa County (Figure 3.1). The county is one of the three counties in the North Eastern region in Kenya. It is located in Eastern Kenya bordering Somalia to the East, Wajir County and Isiolo County to the North, Tana River County at the West and Lamu County to the South (KNBS, 2015). It lies in latitude of 10 58'North and 20 1' South and longitude of 380 34' E and 410 32' E. The county covers an area of 44,174.1 Km^2.(GOK ,2014).

Agriculture and livestock are pilars of the county economy and they are the main sources of occupation ,and livelyhood for farmers and other residents. The county is physiclly flat and topogaraphically. It is lower lying without hills, valleys and mountains. The county is principally a semi-arid area falling within ecological zone and receives an average rainfall of 275 mm per year. There are two rain seasons, the short rains from October to December and the long rains from March to May (KNBS,2015). The temperatures are generally high throughout the year and range from 200^C to 390^C. The average temperature is however 360C. The hottest months are September and January to March, while the months of April to August are relatively cooler(Wanjohi *et.al*, 2012).

Theree sub-counties were choosen for the study;they were Garissa Central (represented by Garissa Township), Garissa East (represented by Dadaab) and Garissa West (represented by Balambale) (Figure: 3.2)

There are fifteen (15) camel slaughter facilaties in the county. Six (6) are located in Blambale sub-county.five (3) is in Dadaab,eight (4) in Township, the others are uncategorized ones and don't operate daily according to the sub-county veterinary officers (SCVO).

Figure 3.1: Map of Kenya showing Garissa County (Kenya political map 2015 and Kenya National Bureau of Statistics, 2013)

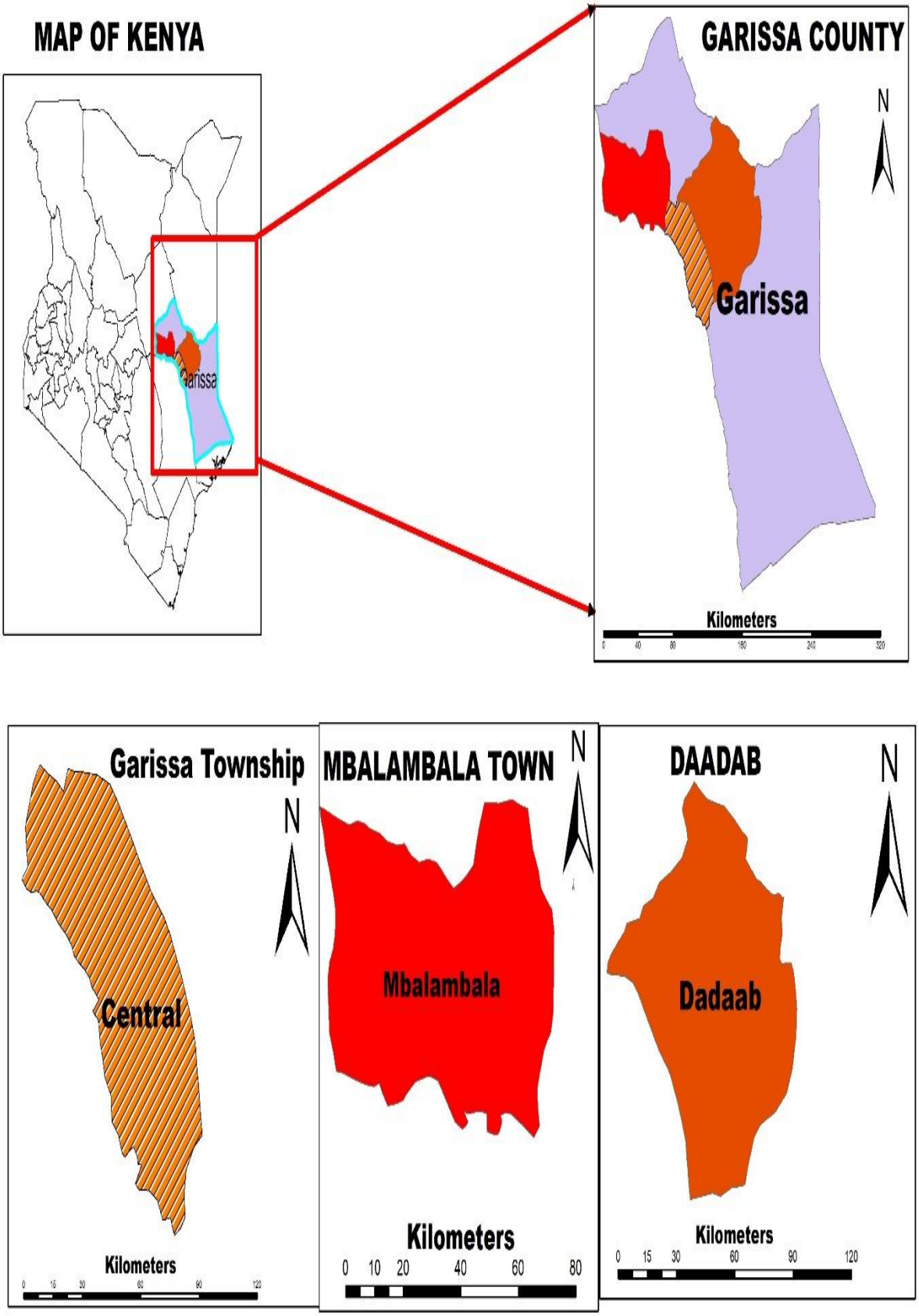


Figure 3.2: **Map of kenya showing the study sub-counties sites (National Bureau of Statistics, 2013)**

3.2: Study Design

This was a cross-sectional study to establish sero-prevalence (and respective pathological lesions) of brucellosis in camels slaughtered in three sub-counties of Garissa County Kenya, including: Garissa central Sub-county (represented by Garissa Township), Garissa East sub-County (represented by Balambale) and Garissa West sub-county (represented by Dadaab); based on avalability of animals (camels) and security. Four serological tests were used, namely: Rose Bengal plate test (RBPT), Serum agglutination test (SAT), competitive Enzyme-linked immunosorbent assay (c-ELISA and Double agar gel immunodiffusion test (AGID). As the animals were brought to the slaughter-grounds they were checked for any signs indicative of brucellosis, for example: lameness, swollen lymph nodes, presence of hygroma(s); This was in addition to reference made to their clinical records taken by veterinarian inspecting the animals (those indicative of brucellosis being: history of abortion, retained placenta, orchitis, epididmitis). Those that had sign(s) or clinical history indicative of brucellosis were recruited into the study. They were tagged/labeled and followed to slaughter, where all condemned organs, if any, were collected, respectively labeled, gross observation done, part(s) with lesion cut-out and placed in 10% formalin for processing for histopathological examination. Of the 238 animals screened, 160 were recruited into the study.

3.3: Selection of slaughterhouses

The selected slaughterhouses in the three study area namely: Garissa Township, Dadaab and Balambale in Garissa-county were selected through convenient sampling methods in consultation with the sub-county veterinary officers. They were selected based on the higher number of camel availability for slaughter and security compared to the other slaughterhouses of the county and available resource for laboratory (data recording, sample collection,

analysis materials and transportation of laboratory material for sampling) and also availability of poste-mortem inspection instruments.

3.4: Study animals and sampling methods

All camels presented for slaughter during the times of visit were examined ante-mortem and records reviewed for signs suggestive of brucellosis. The study animals were apparently health, adult and both sexes. The animal details: tag number, species, sex, breed, age, and owner of the animals were noted and recorded in slaughterhouse interim data capture of sheet (Appendix: 7.6). The slaughterhouses in the sub-counties were conveniently selected for the study. This is because they slaughters a large numbered of camels, they are easy to reach and secure. Only slaughterhouses that handle camels were recruited and visited in a period of four weeks.

3.5: Sample size Determination

The sample size calculation was done using the equation of Andersen, *et.al,* 2010).

$$n = \frac{Z\alpha^2 pq}{L^2}$$

Where; n is required sample size

Zα= 1.96 the normal deviate at 5% level of significant

P A priori estimation of prevalence for the disease

q=1-p and Lis allowable error of estimation

Slaughtered camel: using the highest prevalence estimation of 15% for brucellosis in camel and L is at 5%.

The required sample size was calculated as follows:

$$n = \frac{1.96^2(0.15)(0.69)}{(0.05)^2} \qquad n = \frac{3.8416\ (0.15)(0.69)}{(0.05)^2} \qquad n = \frac{3.8416(0.15)(0.69)}{0.0025} = 160$$

Therefore, sample size per sub-county was calculated based on the number of camels slaughtered per day, which was found to be in the ratio of 4:4:5 for Garissa Township, Dadaab and Balambale, respectively. The respective animals were recruited into the study on several visits to the slaughterhouse until the required number was achieved.

3.6: Sampling method

As mentioned in Section 3.5 above, the sample size was redistributed among the three sub-counties based on respective turn-over rates/number of camels slaughtered per day. Thus, the sampling distribution, with respect to camels with signs indicative of brucellosis, was as follows: 50 for Garissa-township, 50 for Dadaab and 60 for Balambale; the slaughterhouses were visited on separate periods of two weeks each.

3.7: Blood collection and serum harvesting

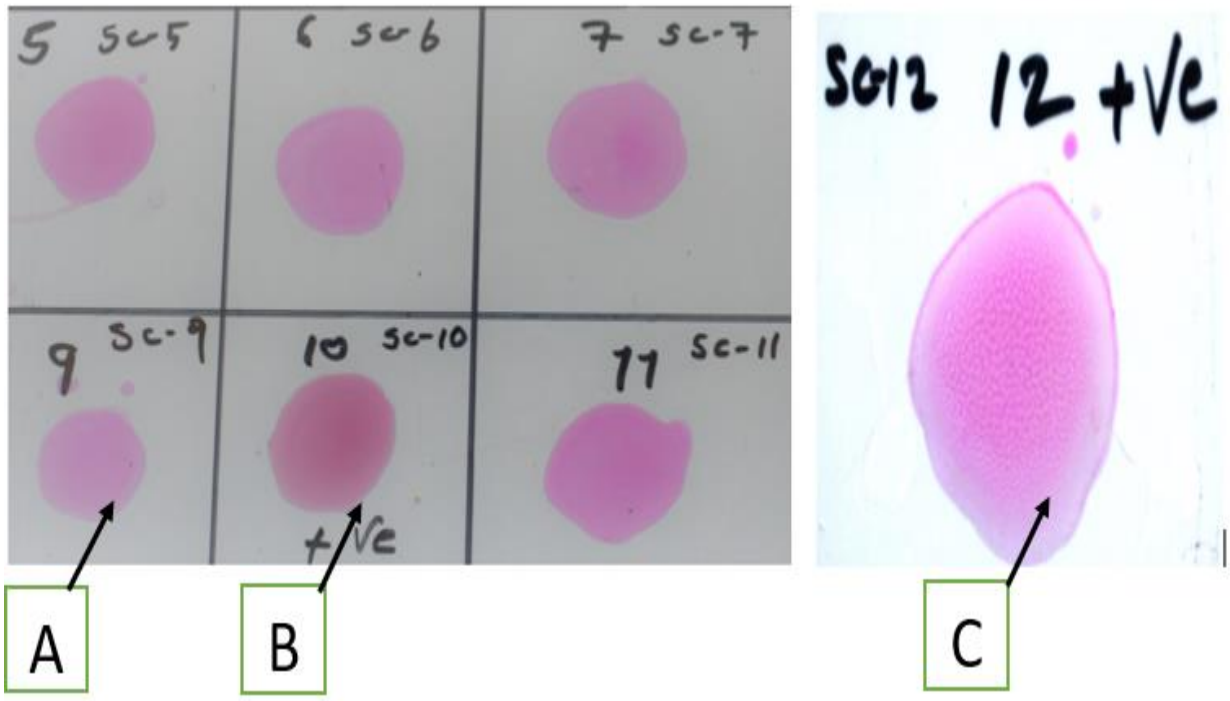
Fifteen millilitres (15ml) of blood was collected from jugular vein using gauge 18 needle and 20 ml syringe. The blood samples were then placed in large test tubes, without anti-coagulant, taken to Garissa Veterinary Investigation Laboratory, where they were left to stand overnight in a cool box to allow for clotting and serum separation. They were then centrifuged at 4,500 xg, serum decanted into cryovials, which were labelled and stored in freezer (-20C^0) at the Veterinary Investigation laboratory office in Garissa County The blood was centrifuged and harvested using the standard procedure of OIE and similarly done by (Liu *et.al*, 2016).

For each serum sample, part of it was used to carry out RBPT and SAT at the Garissa laboratory, while part of it was transported in a cool box to Department of Veterinary

Pathology, Microbiology and Parasitology, Kabete, Nairobi, for carrying-out of c-ELISA and AGID.

3.8: Rose Bengal Plate test (RBPT)

The Rose Bengal test (RBT) was carried out using the method of (Ducrotoy, *et.al*, 2016; and OIE, 2016). The antigen having been obtained from Spain (Instituto de Salud de Navarra, RSA-RB: 330-04:4000; in diagnostics ID vet 149. Spain). The temperature of the serum samples was raised to room temperature (21^{o}C) before testing. Using micro-titre pipette a drop (25µl) of serum was placed on the glossy side of the tile: it was then mixed with a drop (25µl) of antigen. The tile was then rocked up-and-down for up to 4 minutes. Positive result appeared as pink agglutination, while no agglutination was taken as negative reaction. Positive and negative control were also set-up. Therefore, (Figure 3.2) demonstrates one of the test results that has been gained.



A= Negative sample **B= Positive sample** **C= Positive control**

Figure 3.3: Rose Bengal Plate Test showing that Positive and Negative Samples.

3.9: Serum Agglutination Test (SAT)

This test was carried out using the method for (OIE, 2016); the Rose Bengal stained *Brucella* antigen from Spain (Instituto de Salud de Navarra, RSA-RB: 330-04:4000; in diagnostics ID vet 149. Spain). Test serum was double diluted in micro-titre wells; first placing 90 µl of PBS (Phosphate Buffer Solution) in the first well and 50 µl of PBS in the other wells. This was then followed by placing 10 µl of the test serum to the first well; mixed thoroughly, then 50 µl transferred to the next well and mixed thoroughly.

The procedure was then repeated, transferring 50 µl of serum-PBS mixture from the second well to the 3rd one; continuing with the transference of 50 µl of thoroughly-mixed serum-PBS mixture to the next well until the last well. A volume of 50 µl was then removed from the last well and discarded.

Then to each well, 50 µl of antigen was added, mixed thoroughly and the plate incubated Overnight. The positive result appeared as pinkish matt across the well, while negative reaction (no agglutination) appeared as a button at the bottom of the well. Positive and negative controls were also set up. Therefore, Figure 3.3 demonstrates one of the test results got. The highest dilution giving positive reaction was taken as the titre.

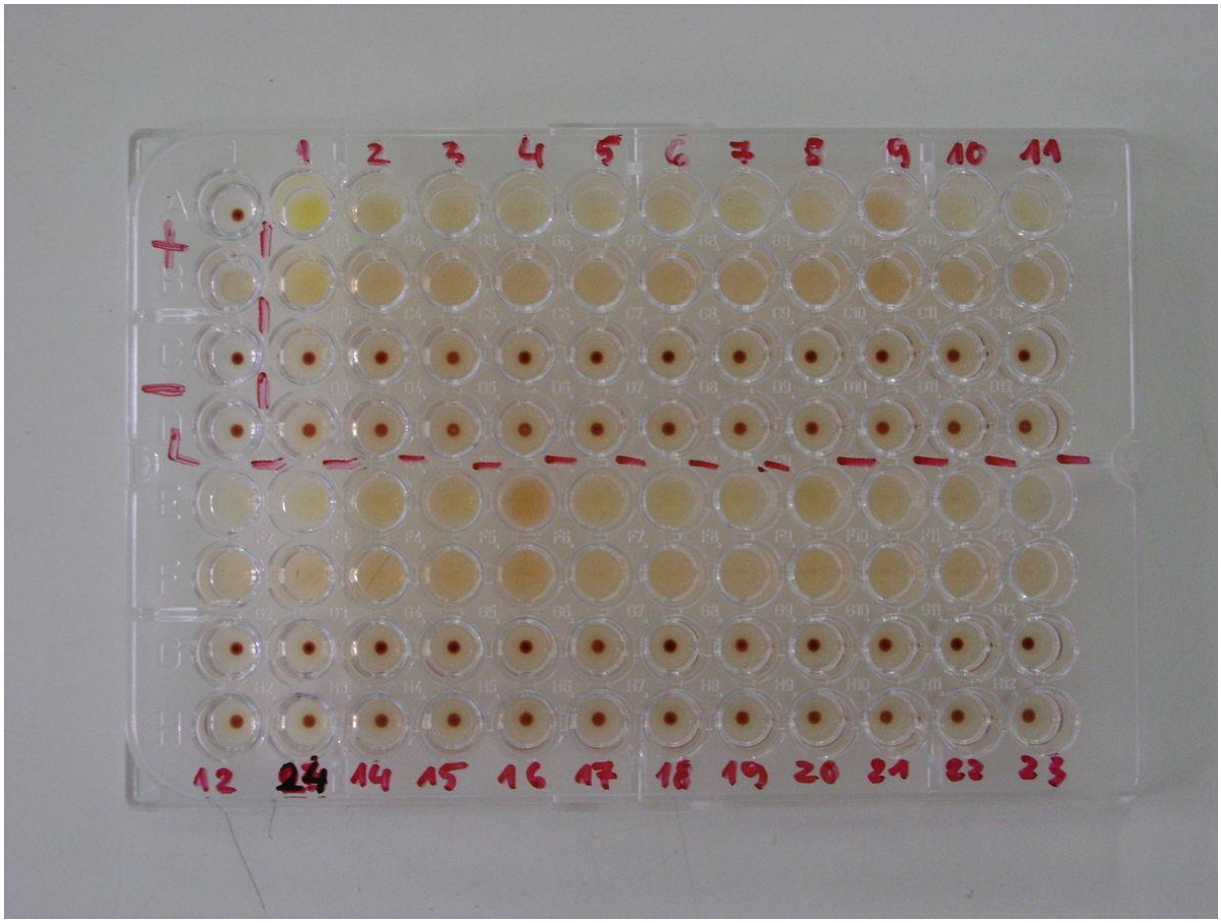


Figure 3.4: Serum Agglutination test (SAT) showing positive and negative reactions

3.10: Comp Elisa Enzyme Linked Immuno-Sorbent Assay (c-ELISA) Tests

This was done using the Compelisa 160 and 400 kit (APHA Scientific) which is standardised for use in diagnosing brucellosis in animals; instructions followed as given for the kit, using micro titre plate and ELISA reader. Diluting buffer, Wash solution, Conjugate, stopping solution and controls were prepared as instructed. The test-steps were as follows:

- The diluting buffer was warmed to room temperature by keeping it on a bench for 20 minutes
- In to microtiter plate, 20 µl of each test serum was added to respective wells, leaving columns 11 and 12 for controls
- 20 µl of positive control was added to wells F11, F12, G11, G12, H11 and H12
- 20 µl of the negative control was added to wells A11, A12, B11, B12, C11 and C12

- No serum was added to the remaining wells in the columns 11 and 12 – they acted as conjugate controls
- Then, immediately, 100 µl of the prepared conjugate solution was added to all the wells. This gave a final serum dilution of 1/6. Therefore, the plate set-up was as given in Appendix 7.5
- The plate was vigorously shaken for two minutes in order to mix the serum and conjugate solution. The plate was covered with a lid and then incubated at room temperature for 30 minutes, on a rotary shaker – at 160 revs/minute
- The contents of the plate were shaken then washed 5 times with tap water. The plate was dried by tapping firmly onto a few layers of filter paper until no more liquid is removed
- Immediately before use, the substrate and chromogenic solution were prepared by dissolving one tablet of urea, H_2O_2 in 12 ml of distilled water. When dissolved, OPD tablet was added and mixed thoroughly, using magnetic stirrer.
- 100 µl of OPD solution was added to all wells, plate incubated at room temperature for 15 minutes
- Micro plate reader (c-ELISA reader) was switched on and allowed to stabilise for 10 minutes
- 100 µl of stopping solution was added to all wells
- Then condensation at the bottom of the plate was removed using filter paper, and the plate read, using the c-ELISA reader, at 450nm – plate read for 10 minute. The respective optical densities (ODs) were then printed-out through computer. Example of printed OD readings of one of the set-tests were as given in (Appendix 7.6).

Reading of the test: Lack of colour development indicated the sample tested was positive. A positive/negative cut-off point was calculated as 60% of the mean of the optical density (OD) of the 4 conjugate control wells. Any test sample giving an OD equal to or below this value was regarded as being positive

Plate acceptance criteria (validation; following the kit's instructions)

The results were considered valid when the situation was as follows:

- The mean OD of the 6 negative control wells was greater than 0.700 (the optical mean negative OD is 1000)
- The mean OD of the 6 positive control wells was less than 0.100
- The mean OD of the 4 conjugate control wells was greater than 0.700 (the optical mean conjugate control OD is one (1).
- The binding ratio was greater than 10. Binding ratio was calculated as follows:

$$\text{Binding Ratio} = \frac{mean\ of\ 6\ negetive\ control\ wells}{mean\ of\ 6\ posirive\ control\ wells}$$

3.11: Agar Gel Immuno-diffusion test (AGID)

Slide Agar Gel double Immunodifusion Test (AGID) was carried out following the method of (Wattam, *et.al,* 2012). Using *Brucella abortus* antigen. Five wells were dug into solidified agar, prepared earlier on a microscope slide at the periphery and one at the centre using a well-puncture. The central well was then filled with the test serum while the outer wells were filled with the brucella antigen.

The slide was then incubated up-side-up at room temperature in a humid chamber /petri-dish for up to 48 hours, after which it was stained with Coomassie blue for five minutes, then distained using a distaining solution; following the method of (Tahiri, *et al*. 2017).

Presence of curved precipitation line(s) as demonstrated in Figure 3.5 indicated positive reaction. Positive and negative controls were also set-up.

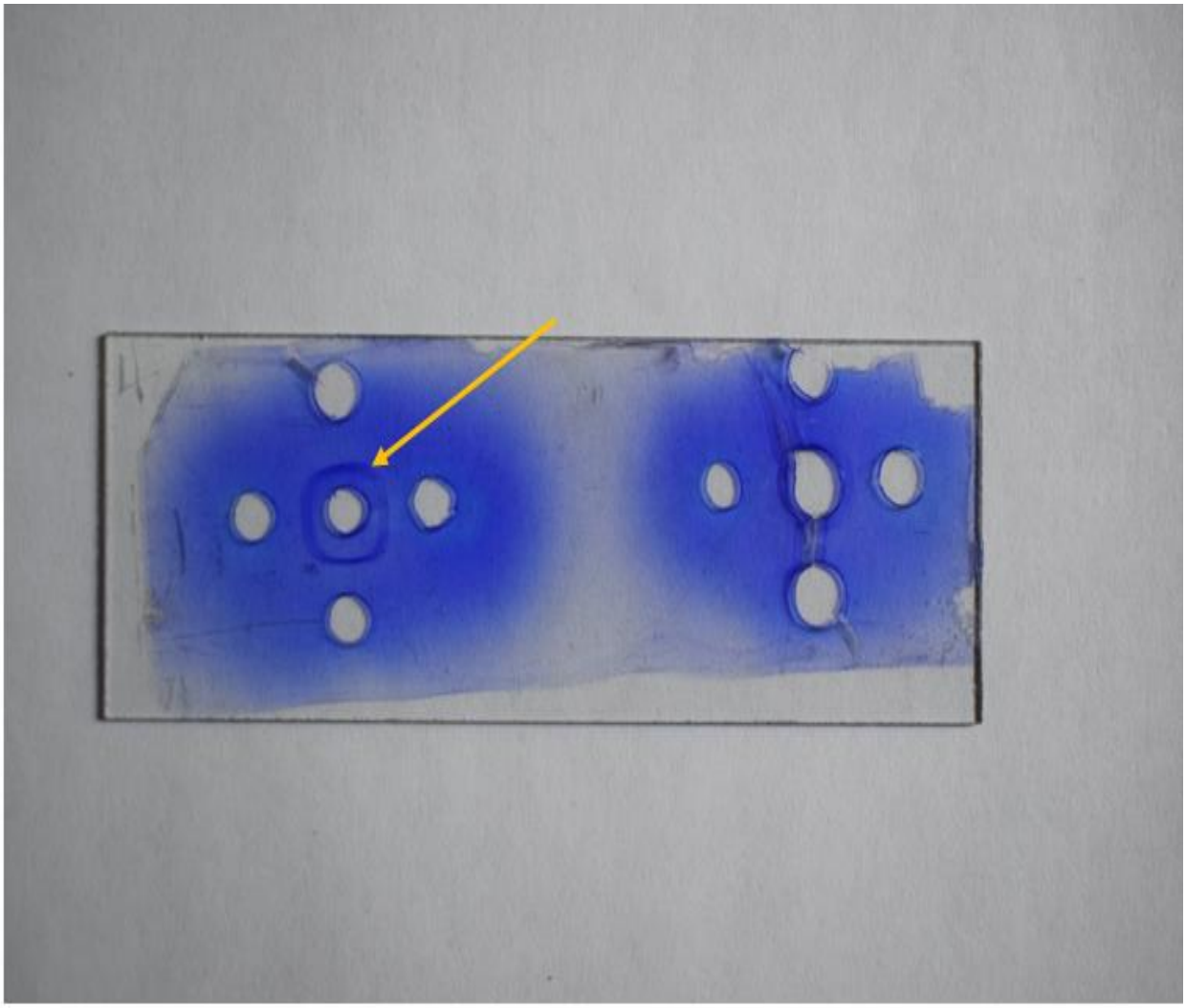


Figure 3.5: Agar Gel Immunodiffusion (AGID) showing positive reaction {precipitation lines (arrows)}

3.12: Documenting for gross and Histopathological lesions of brucellosis and suspect condemned organs

All condemned organs from the test animals were further examined grossly and microscopically. At the post-mortem inspection, organs condemned were grossly examined and sampled for histopathology.

3.12.1: Gross Examination

Gross-examination of condemned organs from test camels which were mainly lung, lymph nodes, heart, liver and kidney, was carried out by visual, observation, palpation and opening of the effected organs. Special attention was given to size of the organ, colour, and appearance. This was to check for lesions indicative of brucellosis. From each Slaughterhouse visited, after ante-mortem examination and carried out of RBPT, the labelled sero-positive animals were followed to the slaughter area and any condemned organ(s) were respectively labelled, gross examination carried-out and samples taken for histological examination. For further Pathological and macroscopically examined (Appendix 7.7). The observed lesions were described, for location, distribution, colour, size and recorded for diagnosis. The morphological lesions and other suspected abnormalities were also recorded in printed form (Appendix 7.9).

The carcasses were disposed of in slaughterhouse departmental disposal container after proper disinfectant of all surfaces and materials during post-mortem examination by using (Benzyl, dimethyl, Ammonium-chloride and Cooper manufactured, Kenya). Photographs of the lesions were taken using by a digital camera (sonny CSD –W920 having three optical camera Magnification X40, X10, X100 and X400) and transferred into a computer and labelled appropriately.

3.12.2: Processing of samples for Histopathological examination

The collected tissue samples were fixed 10% Formalin and stained following the slandered protocol of (OIE, 2012) and (FAO, 2014). The fresh tissue was placed in 10% formalin and then transported to The University of Nairobi Department of Veterinary Pathology, Microbiology and Parasitology (VPMP). The fixed tissues were then trimmed with sliced to a thickened of 5 mm and dehydrated Alcohol for at the intervals of one and half hour (½) by

utilizing of ethanol alcohol for 4 hours. They were cleared, infiltration with the liquid paraffin wax (paraplast) at 60 ^{0}C in two changed for the three hours per each and embedded in paper with wax, fixed into the wooden block by using hot searing spatula. The tissue was cut in to the 5µm by blocking and microtoming to the specimen. They were dewaxed in each spaceman for 5 minutes. The tissue was rehydrated and putted distilled water for 5 minutes in each section of the specimen.

The section was stained by using haematoxylin and eosin (H&E). The cover slip was applied by DPX (Dibutylphthalate xylene). The sectioned tissue was inspected under light microscope lens utilizing; x4, x10, and x40 amplification then the pathological lesions were recorded according to the affected organs.

3.13: Data analysis and Presentation

The information (data) were gathered through descriptive examination from the investigation zones, revised composed and organized. So that the obtained data from, serological tests and pathological lesions were recorded in research notebook and entered the spread sheet of (Ms-Excel) and analysed by state for windows (Version 14.0). Chi Square test (X^2) was used for comparing positivity of the disease from selected slaughtered camel through the pathological lesions of the infection to the other suspected diseases.

CHAPTER FOUR: RESULTS

4.1: Camels sampled at slaughter

A total of two hundred and thirty eight (238) of one humped camels were presented at the slaughterhouses and examined. Out of these one hundred and sixty Camels which showed signs of brucellosis or came from a herd with history of brucellosis were included in the study. Of which 70(62.5%) were male while 42(37.5%) were females. All slaughtered camels were adults and one humped (dromedary) 87(54%) were Somali Breed, 42 (26%) Rendilla/Gabbra and 31(19%) were Turkana Breed. The most organ condemned, were lymph nodes, liver, lung, kidney and heart. Those organs were condemned for various reasons.

4.2: Sero-prevalence study results

Results of the four (4) serological tests used: Rose Bengal Plate (RBPT), Serum Agglutination Test (SAT), Competitive Enzyme-linked Immuno-Sorbent Assay Test (c-ELISA) and Ager Gel Immuno-Diffusion Test (AGID) were given below:-

4.2.1: Rose Bengal Plate Test (RBPT)

When the camel serum samples from selected slaughterhouses in Garissa sub-counties were tested using the Rose Bengal Plate Test (RBPT). Fifteen (15) samples (9.3%) tested positive. **(Table 4.1).** From Garissa-township (n=50) four (4) samples (8.0%) were tested positive, fifty (n=50) samples from Dadaab slaughterhouses six (6) (12.0%) were tested positive while (n=60) from Balambale (n=60) five (5) samples (8.3%) were tested positive. Thus, this test picked Dadaab as having had the highest reactor rate (12.0%); overall reactor rate was 9.3%.

Table 4.1: Rose Bengal Plate Test (RBPT) results overall and with respect to the three study area of Garissa County Kenya.

Study area	No. tested	No. positive	% Positive
Overall	160	15	9.3
Garissa township	50	4	8
Dadaab	50	6	12
Balambale	60	5	8.3

4.2.2: Serum Agglutination Test (SAT)

When one hundred and sixty camel serum samples from selected slaughterhouses in Garissa sub-counties were tested using the Serum Agglutination Test (SAT). Sixteen (16) samples (10.0%) tested positive (Table 4.2). From Garissa-township (n = 50), 4 samples (8.0%), tested positive. from Dadaab (n = 50) 6 samples (12.0%) tested positive and while from Balambale (n=60) 6 samples (10.0%) tested positive. Thus this test picked Dadaab as having had the highest reactor rate (12.0%); overall reactor rate was 10.0%.

Table 4. 2: Serum Agglutination Test (SAT) results overall and with respect to the three study areas of Garissa County, Kenya

Study area	**No. tested**	**No. positive**	**% Positive**
Overall	160	16	10
Garissa township	50	4	8
Dadaab	50	6	12
Balambale	60	6	10

4.2.3: Compelisa Enzyme Linked Immunosorbent Assay Test (c-ELISA)

When the 160 camel serum samples from selected slaughterhouses in Garissa sub-counties were tested using the Competitive enzyme-linked immunosorbent assay (cELISA), 15 samples (9.3%) tested positive (Table 4.3). From Garissa-township (n = 50), 4 samples (8.0%) tested positive; from Dadaab (n = 50), 6 samples (12.0%) tested positive; while from Balambale (n = 60), 5 samples (8.3%) tested positive. Thus, this test picked Dadaab as having had the highest reactor rate (12.0%); overall reactor rate was 9.3%.

Table 4.3: Comp Elisa Enzyme-linked Immuno-sorbent Assay (c-ELISA) test results overall and with respect to the three study areas of Garissa County, Kenya

Study area	No. tested	No. positive	% Positive
Overall	160	15	9.3
Garissa township	50	4	8
Dadaab	50	6	12
Balambale	60	5	8.3

Therefore, the unit value of competitive enzyme-linked immunosorbent assay (c-ELISA) obtained also indicated the level of antigen from different samples tested (similarly to wanjohi *et.al* 2012; Keven *et.al* 2015and Baigent *et.al* 2016).

4.2.4: Agar Gel Immune Diffusion Test (AGID)

When the 160 camel serum samples from selected slaughterhouses in Garissa sub-counties were tested using the Double agar gel difussion test (AGID), 11 samples (6.8%) tested positive (Table 4.4). From Garissa-township (n = 50), 2 samples (4.0%) tested positive; from Dadaab (n = 50), 3 samples (6.0%) tested positive; while from Balambale (n = 60), 6 samples (10.0%) tested positive. Thus, this test picked Balambale as having had the highest

reactor rate (10.0%); overall reactor rate was 6.8%. Therefore, the test has been used mainly by its high several authors that have reported its special ability to differentiate between S-19 vaccinated and naturally infected animals, when using soluble antigens**.** The test was performed following previous recommendations (Makita, *et.al*, 2011).

Table 4. 4: Agar Gel Immuno-Diffusion Test (AGID) results overall and with respect to the three study areas of Garissa County, Kenya

Individuals /Groups	***B. melitensis***	***B. abourtus***	**Percentage (%)**
Infected camel of Garissa-township	Se (%)	Sp (%)	
(n=2)	1	1	**2.0**
infected camel for Dadaab	Se (%)	Sp (%)	
(n=3)	2	4	**6.0**
Infected camel for Balambale	Se (%)	Sp (%)	**10.0**
(n=6)	4	6	
Total number of infected camels	Se (%)	Sp (%)	**6.875**
(n=11)	3.43	3.43	
Total number of non-infected camel	Se (%)	Sp (%)	**93.12**
(n=149)	46.52	46.52	
Vaccinated slaughtered Camel	Se (%)	Sp (%)	**38.12**
(n=61)	19.06	19.06	

Se = sensitivity;

Sp = specificity;

DVSC = Different vaccinated Slaughtered Camel.

Although, on face value, SAT seems to be the most sensitive (picked more positive cases) (10%) and AGID seemed to be the least sensitive (6.8%), When sensitivities of the 4 serological tests were compared (Table 4.5), using the Chi square goodness of fit test, there was no significant difference between them, with respect to picking of positive cases (p was = 0.0999**).**

Therefore, Figure 1 gives the comparative results (percent) for the 4 serological tests, with respect to the study areas. Apart from AGID, which picked Balambale as having highest reactor rate, the other three tests picked Dadaab as having the highest reactor rate. Detailed statistical analysis out-put for the four test compared in (Appendix 7.11).

Table 4.5: Comparison of results (percent) got using the four (4) serological tests, overall and with respect to the study areas

Tests	**Township (n=50)**	**Dadaab (n=50)**	**Balambale (n=60)**	**Overall : (n=160)**
RBPT	4(8%)	6(%)	5(8.3%)	15(9.3%)
SAT	4(8%)	6(12%)	6(10%)	16(10%)
c-ELISA	4(8%)	5(10%)	6(10%)	15(9.3%)
AGID	2(4%)	3(6%)	6(10%)	11(6.8%)
Average	4(8%)	5(10%)	6(10%)	14(8.75%)

4.3: Results of condemned organs

In total of one hundred and sixty (160) camels were inspected to examine for gross pathological lesions and histological lesions. Fifty (31%) were slaughtered at Garissa-township, fifty (31%) at Dadaab and sixty (37%) at Balambale slaughterhouses. Results of the gross and microscopic examination of the condemned organs were as given below.

4.3.1: Numbers of organ condemned

Of the160 camels that were inspected and examined, 78 (48.75%) of them had at least one pathological condition, 55 (70.5%) had one pathological lesions each, 19(24.4%) had more than pathological lesions, while 38(48.7%) had no organ condemnation. At Garissa-township slaughterhouse, of 50 camel slaughtered 35(70%) had one (1) pathological lesions, (14%) had more than one (1) pathological lesions each, while the other 8(16%) had no organ condemned.

At Dadaab out of the 50 camel slaughtered, 30(60%) had one (1) pathological lesion each, 10(20%) had same pathological conditions while other 10(20%) had no organ condemnation. At Balambale slaughterhouses, out of the 60 camels slaughtered 40(66.6%) had no organ condemned, 15 (25%) had more than one pathological lesions while others 5 (8.3%) had one same pathological lesions at the slaughter (Table 4.6 :).

Table 4.6: Number of organs condemned per slaughterhouse, with respect to the number of camels slaughtered

Numbers of condemned organs	**Distribution (number and %) per Slaughterhouses**			Total (%)
	Garissa-township	Dadaab	Balambale	
Number having pathological lesions	35	18	25	78(48)
Numbers having one pathological lesions	20	13	22	55(70)
Number of condemned organs	7	6	7	19(24)
No condemnation numbers	16	8	14	38(48)
Total animals examined	**50**	**50**	**60**	**160**

4.3.2: Types of organ condemned

Type of organs condemned from the One hundred and sixty (160) slaughtered camels include the following: 78 (48.7%) were lymph nodes. For Garissa-township 48(61.5%), at Dadaab 18(23%) had condemned as whole, and Balambale 12(15.3%) were partially condemned. 28(17.5%) of livers were condemned. For Garissa-township slaughterhouses 12(42.8%) had condemned as whole, at Dadaab slaughterhouses 9(32.2%) were condemned as partially while Balambale slaughterhouses 7(25%) were condemned as whole. 18(11.2%) of lung had also condemned.at Garissa-township, 5(27.7%) has condemned as whole, at Dadaab slaughterhouses 7(38.8%) had condemned as whole, while At Balambale slaughterhouses 3(16.6%) were condemned partially. 20 (12.5%) kidney Garissa-township 9(45%) ,6(30%) at Dadaab and 5(25%) at Balambale slaughterhouses were condemned as whole .16(10%) heart muscle, 4(25%) at the Township, 5(31.2%) at Dadaab slaughterhouses and 7(43.7%) at Balambale slaughterhouses were condemned as partially (table 4.7.) had the greatest number of organs condemned.

Table 4.7: Respective condemnation rate of organs, overall and with the respect to the three different study areas

Condemned Organs	Township	Dadaab	Balambale	Overall
Lymph node	48(61.5%)	18(23%)	12(15.3%)	78(48.7%)
Liver	12(42.8%)	9(32.2%)	7(25%)	28(17.5%)
Lung	6(33.3%)	7(38.8%)	5(27.7%)	18(23%)
Heart muscle	4(25%)	5(31.2%)	7(43.7%)	16(10%)
Kidney	9(45%)	6(30%)	5(25%)	20(12.5%)
Total camel examined	79	45	36	160

4.3.3: Clinical, Gross and Histopathology study results

A total of 160 camels were included in the study using clinical signs manifested and clinical records that were indicative of them suffering from brucellosis. During the study period. according to the ante-mortem record, clinical manifestation were lameness 48(30.0%), swollen of lymph node 39(24.0%)(figure 4.1), Orchitis 6(3.70%), infertility 7(4.3%), Abortion 8(5.0%), Abdominal pain 7(4.3%), decreased milk yield 7(4.3%), inflammation of testicles 6(3.7%), epididymitis 6(3.7%), Anorexia 7(4.3%), in appetence 7(4.3%), infection of urogenital 7(4.3%), and placental infection 6(3.7%). Figure 4.1 shows a picture of swollen lymph node seen in one of the camels. Detailed clinical manifestation for each examined animals are as given in (Appendix7.7).

Condemned organs/tissues were collected and examined, both grossly and microscopically, from the slaughtered camels. The gross condemned lesions encountered were: fibrin depositions 7(4.3%), enlargement of lung 6(3.7%), pericarditis 38(23.7%), and hepatomegaly with nodular liver lesions 79(49.3%), enteritis 5(3.1%), haemorrhages 6(3.7%), congestion 8(5.0%), of visceral organs (lung and kidney) and abscess of lymph nodes 3(1.8%). Details of gross pathological lesions based on specific examinations are given in in Garissa County (Appendix 7.8).

Figure 4.1: Camel number 14 (SC-14) which had tested sero-positive for brucellosis showing swollen lymph nodes (blue arrow)

The histopathology in counted were included cellular infiltrations 15 (6.2%), hypoplasia 3 (1.8%), collapse of alveoli 7 (4.3%), oedema 4 (2.5%), congestions 6 (3.7%), fatty degeneration 5 (3.1%), haemorrhages 9 (5.6%), immunoblastic infiltrations 8 (5.0%), increase in number of lymphocytes 9 (5.6%), pneumonia 10 (6.2%), lymphoblastic infiltrations 8 (5.0%), fibrosis 7 (4.3%),macrophages and neutrophils 10 (6.2%),inflammatory cells 9 (5.6%), cellular injuries 8 (5.0%),accumulated of blood cells 8 (5.0%), compensatory Emphysema 9 (5.6%), increase in number of hepatocyte cells 10 (6.2%), inflammatory lesions in skin 8 (5.0%), and also recorded necrosis in myocardium 7 (4.3%).

Therefore the pathological changes of sero-reactants in condemned organs (Table 4.7), Figures 4.2 to 4.11 give the various histopathological pictures got in selected condemned organs. Details of gross histological lesions for specific examinations are given in (Appendix 7.11). Therefore, the pathological changes that came out after the gross lesions record with the respective *Brucella* Positive are mentioned below in the table 4.8: and the table gives the details of only positive results in the tested serology while the rest of samples which were negative tested result as indicate in the appendix 7.11: which is below,

Table 4.8: Pathological changes of condemned organs with the respect to *Brucella* sero-reactants in slaughtered camels in Garissa County.

CAMEL No.	COND.ORGANS	CLINI. SIGNS	GROSS LESIONS	HISTOPATHOLOGY
SC-GT-12	Lymph node	Swollen	Enlargement and abscess	Cellular infiltration
	Stomach	loss of appetite	Discoloration	Haemorrhages
SC-GT-14	Lung	Lameness	Change in colure , white spots	collapse of alveoli, pinkish fluid materials with the alveoli (Oedema)
SC-GT-24	Liver	Lameness	Distended	Fatty degeneration
	Liver	Placental infection	Thickened of bile duct	Diffuse of fatty infiltrations
SC-GT-29	Lymph node	Swollen of lymph nodes	Swollen	immunoblastic infiltration
SC-GT-30	Heart	Anorexia	fibrins and haemorrhages	destructions of fibrins
SC-DA-64	Lung	In appetence	Discoloration	Pneumonia
SC-DA-69	Heart	Placental infection	Congested	Lymphoblastic infiltrations
SC-DA-70	Kidney	Epididymitis	Congested	Congestion and haemorrhages
SC-BA-120	Heart	Infertility	Fibrins	Slightly destruction of fibrins
SC-BA-132	Lung	Abdominal pain	Congested	Polymorph-nuclei in Alveoli
SC-BA-143	Kidney	Abortion		
SC-BA-144	Lymph node	Swollen of lymph nodes	Enlarged in some areas	Increase number of lymphocytes
SC-BA-150	Heart	Infection of urogenital	Haemorrhages	Macrophages and neutrophil infiltrations
SC-BA-155	Liver	Anoxia	Hepatomegaly	Oedematous mononuclear cells
SC-BA-158	Kidney	Abortion	Congested	Congested and haemorrhages

4.3.4: Gross morphology and histopathology appearances for the sero- positive condemned organs

4.3.4.1: Lymph node

The examination of lymph node tissue from slaughtered camel in Garissa-Township whose sera was tested positive to the brucellosis had immunoblastic infiltrations, hypoplasia (meaning that underdevelopment or incomplete development of a tissue or organ), and few mature lymphocytes and increase number of lymphocytic cells were observed in lymph nodes for grossly and histopathology features **(**Figure:4.2,3and 4). The lymph node of sampled from negative camel ten (10) and twelve (12) had similar lesions.

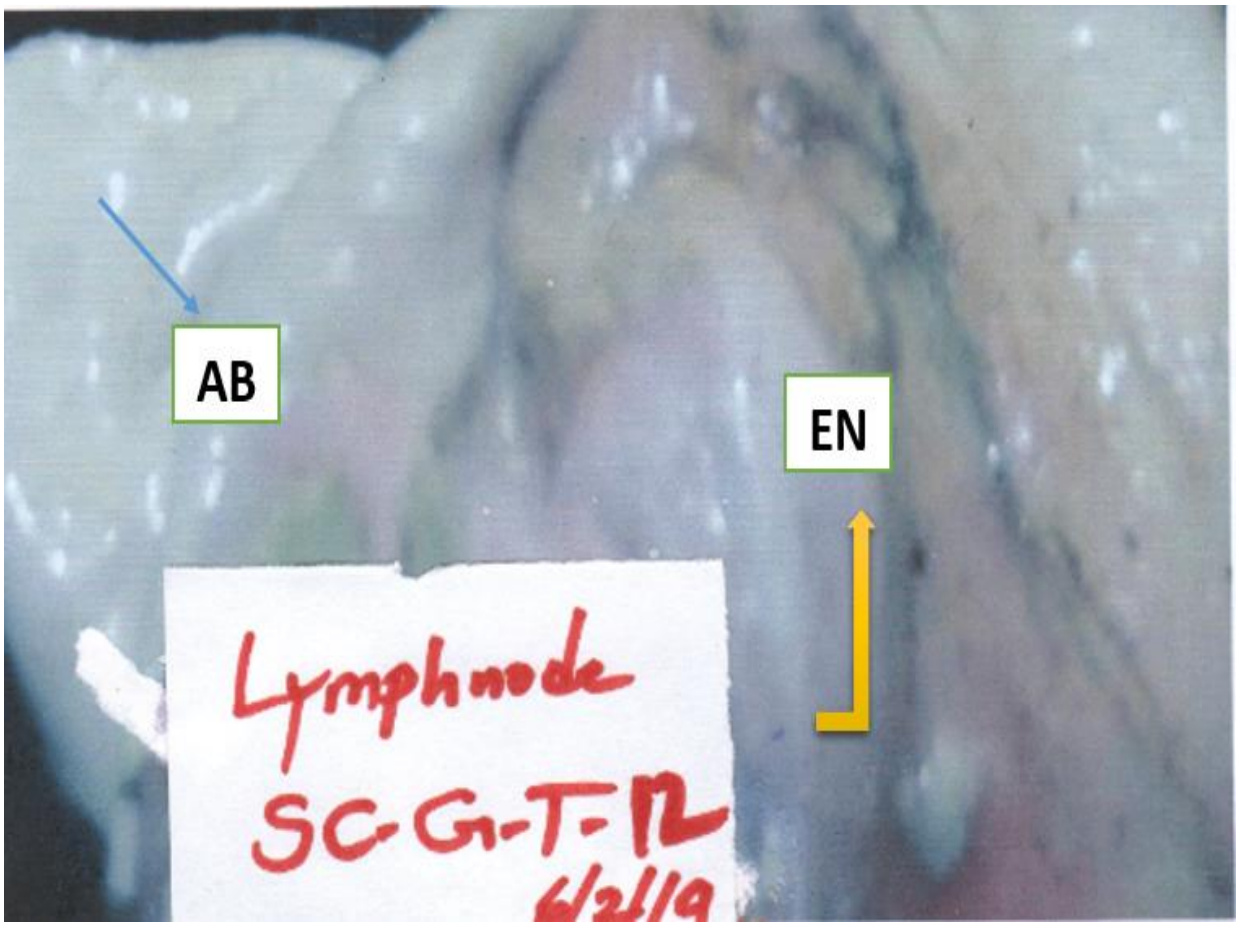


Figure 4.2: Respective condemned organ of tested positive lymph node (Suppermamary glands) at the serology from Sample camel (SC-GT-12) that diagnosed enlarged (EN) and Abscesses (AB)

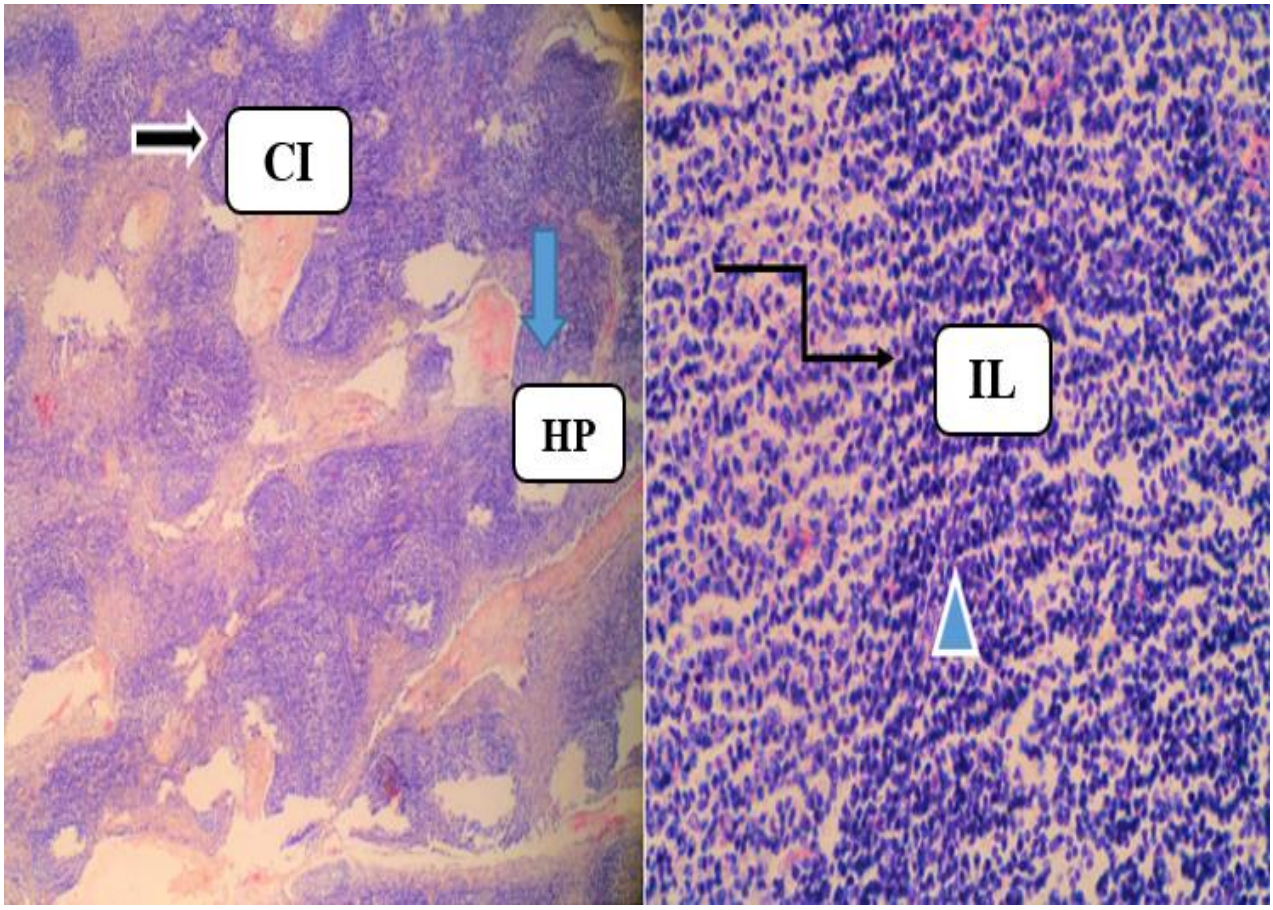


Figure 4.3: Histopathology of Lymph node for brucellosis-positive Camel case number (SC-12) showing immunoblastic infiltration, Cellular infiltration (CI); hypoplasia of lymphocytes (HP) and increase number of lymphocytes (IL) and stained with (H/E).

For higher magnification of increasing in number of lymphocytes as demonstrated bellow in figure 4.4:

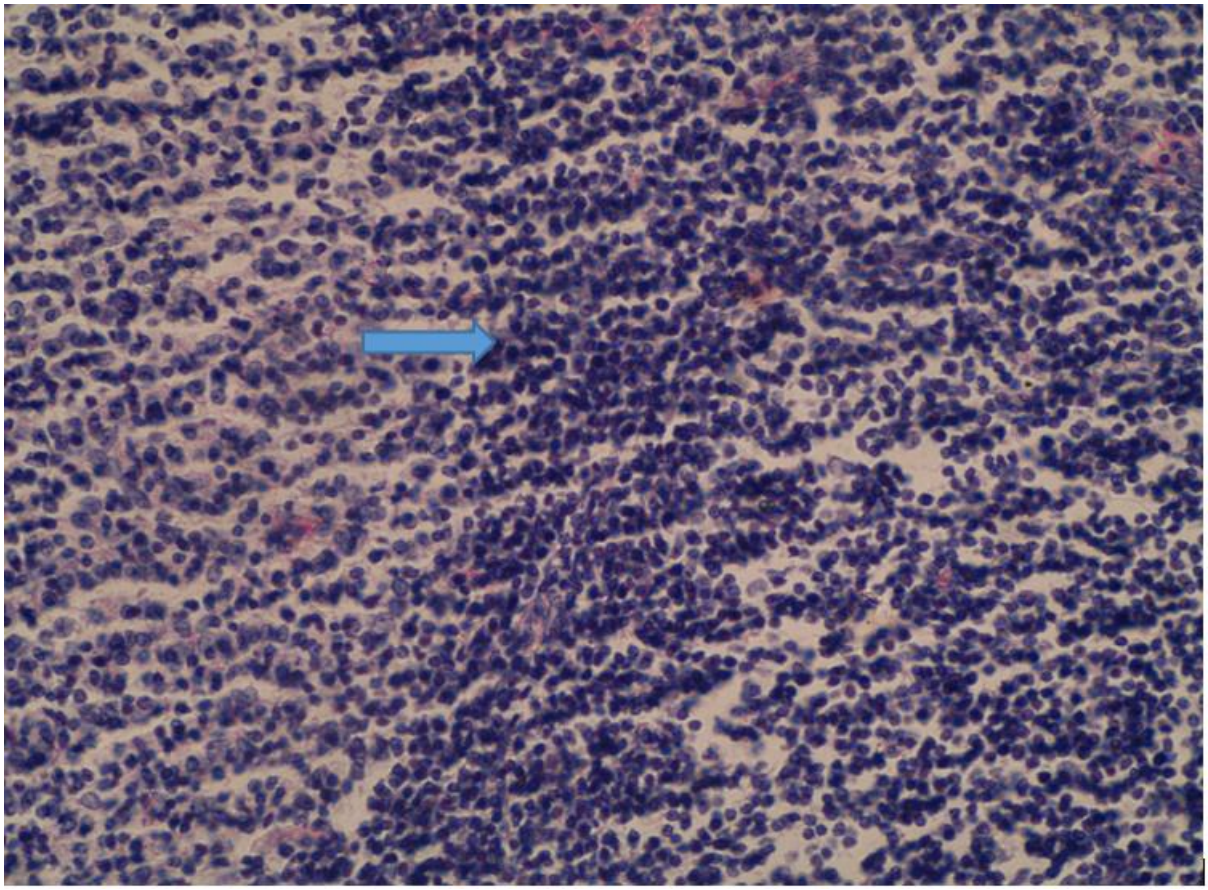


Figure 4.4: A Lymph node of condemned organ from tested positive in the same sample indicating that increasing number of lymphocytes in higher magnification and stained with (H&E)

4.3.4.2: Lung tissue

The lung tissue from positive camel with brucellosis had verified collapse of alveoli, pinkish fluid materials with the alveoli (Oedema), Pneumonia, infiltrations of polymorphonuclear cells (is a type of immune cell that has granules (small particles) with enzymes that are released during infections, allergic reactions, and also asthma) and neutrophils in bronchioles for grossly and histopathology photomicrography (Figure: 4.5 and 6). However, the lung had thickened alveolar walls with interstitial mononuclear infiltrate, congestion in some areas and haemorrhages. There was negative sampled lung tissue of camel five and nine showed similar lesions.

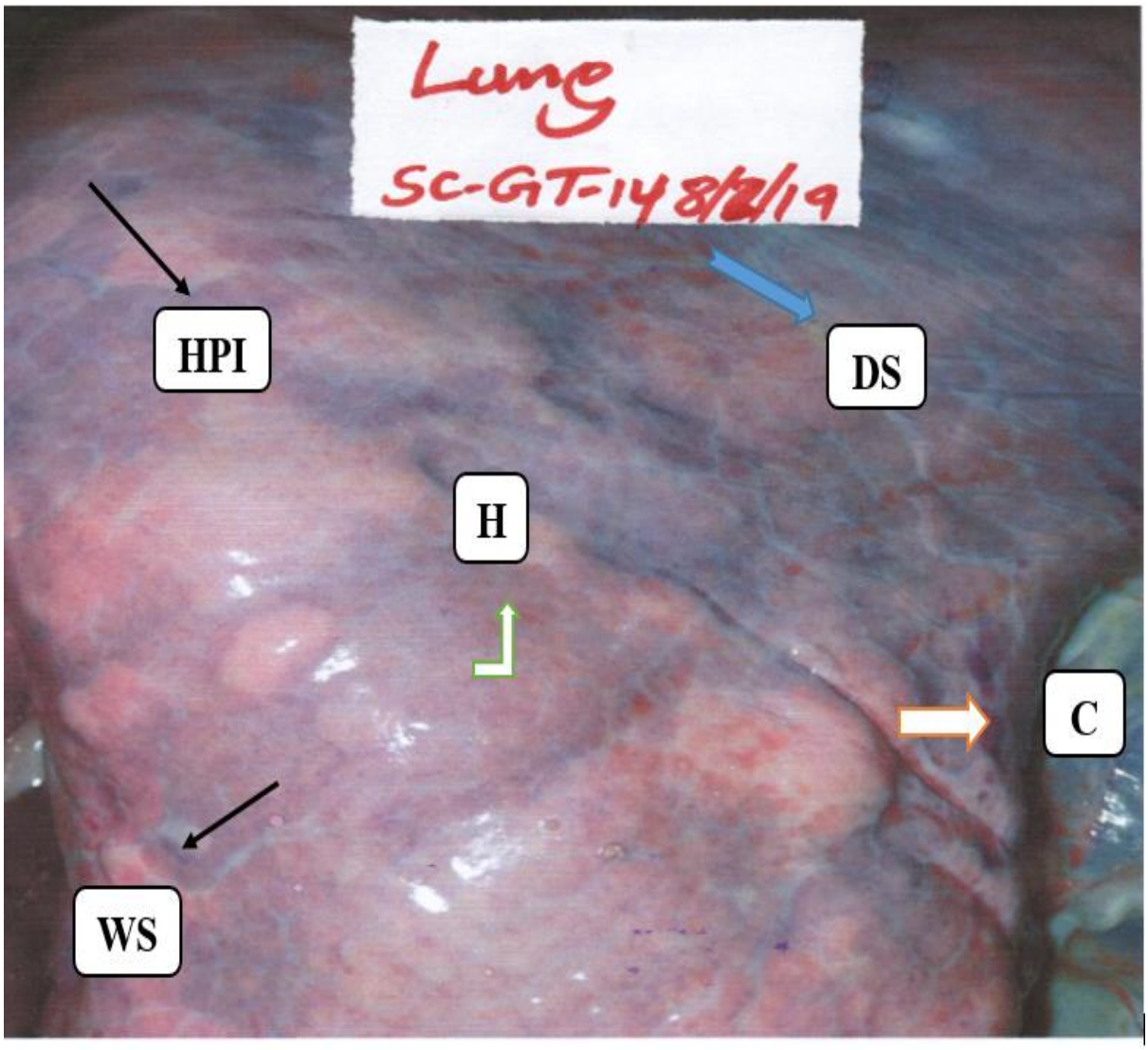


Figure 4.5: Condemned organ of lung of tested positive obtained from sample camel (SC-GT-14) showing Hyper-inflated (HPI) Discoloration (DS) white spots (WS), Congested (C) and Haemorrhages (H).

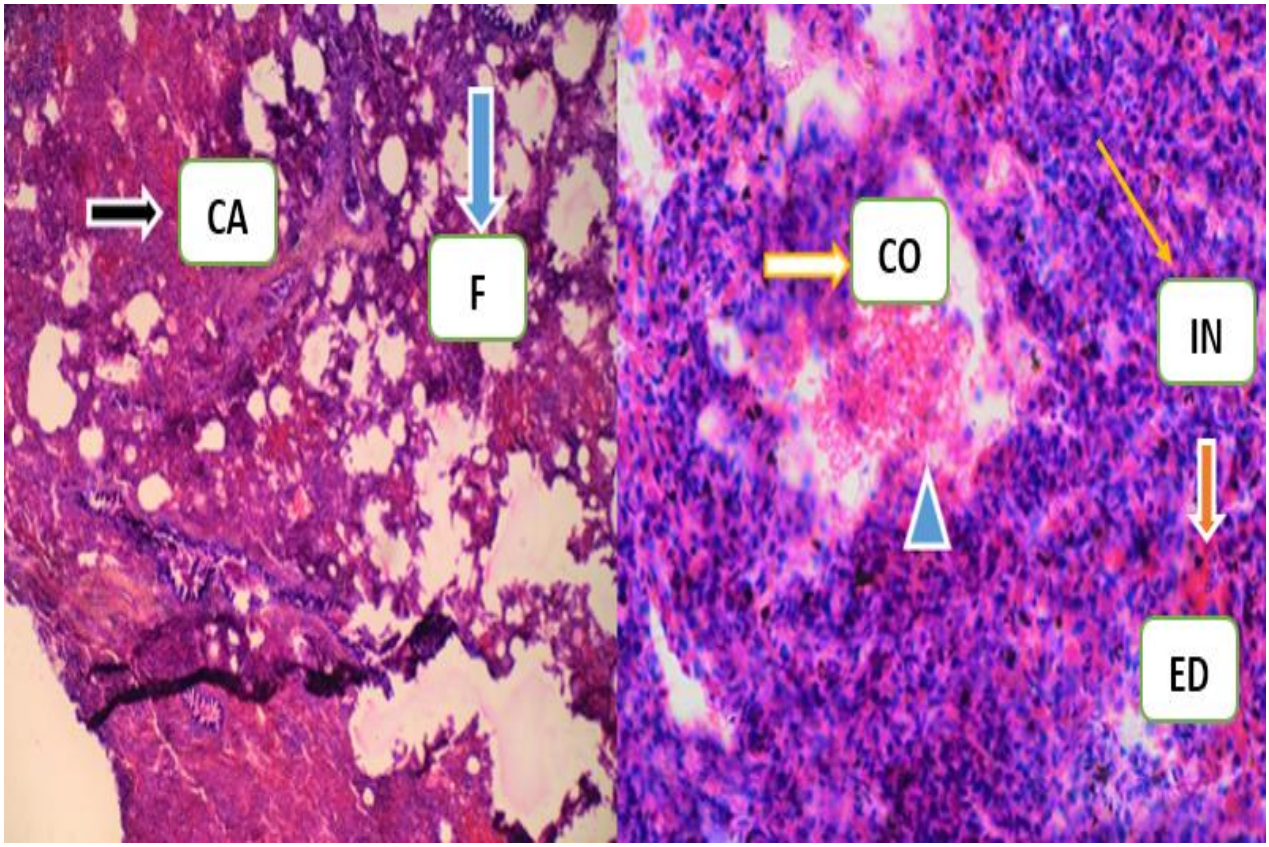


Figure 4.6: Histopathology of lung tissue for positive –brucellosis obtained from camel case number SC-GT-14 showing that collapse of alveoli (CA), pinkish fluid materials (F) in alveoli (Oedema)(ED), Pneumonia, infiltrations of polymorph-nuclear cells (IN) and heavy congestion (CO) and it stained with the (H/E).

4.3.4.3: Heart muscle

The heart tissue from seropositive camel of brucellosis had heavy fatty degeneration, lymphoblastic infiltrations in cardiac muscles, slightly destructions of fibrins in cardiac, in some areas there was macrophages and neutrophilic infiltrations for grossly and histopathology photomicrography (Figure 4.7 and 8) and also inflammatory cells are more in heart section. However, in a sampled sero-negatives camels eight (8) and Nine (9) had similar pathological lesions

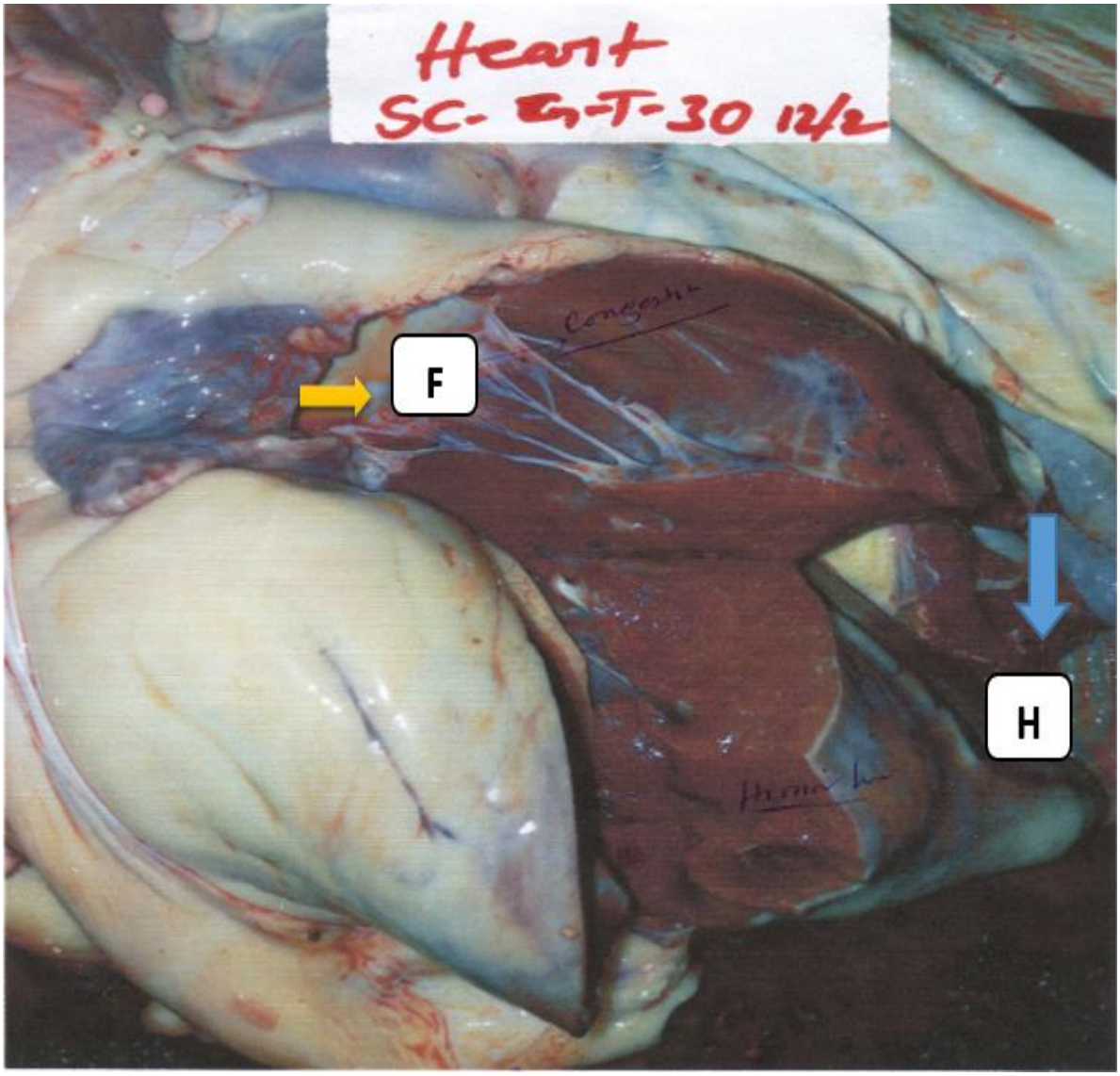


Figure 4.7: A Sample of heart acquired from sample camel (SC-GT-30) that showing fibrins (F) and haemorrhages (H) in slaughtered camel.

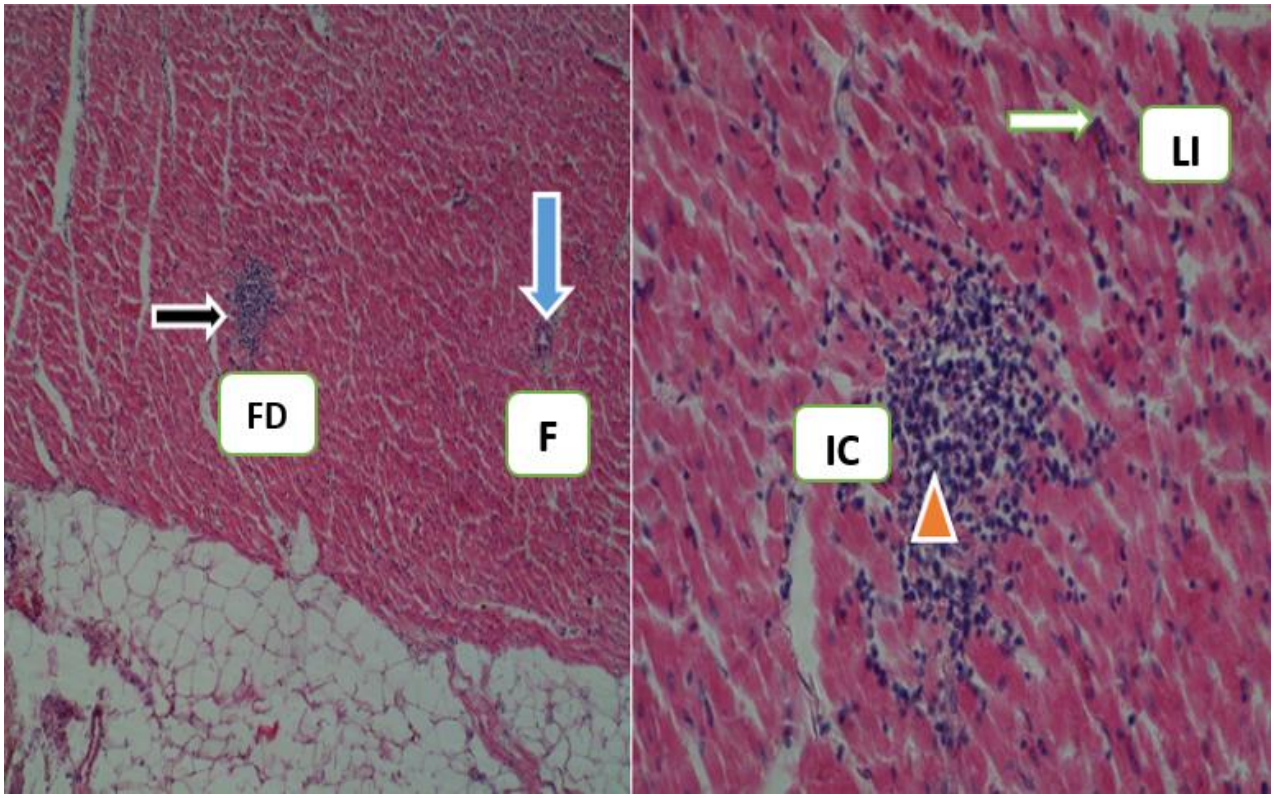


Figure 4.8: Histological features of heart from Positive tested camel obtained from Sample camel number (SC-GT- 30) showing that fatty degeneration (FD), lymphoblastic infiltration (LI) in cardiac muscles, slightly destructions of fibrous (F), macrophages, Neutrophil infiltrations in some areas and inflammatory cells (IC) and stained with (H/E).

4.3.4.4: Liver

The liver tissue from seropositive camel of brucellosis was viewed fatty degeneration, Neutrophils, liver injuries, diffuse fatty infiltration (meaning that accumulation of excess fat in the liver) mononuclear cells, lymphoblastic cellular of infiltration and congestions in some areas for gross morphology of condemnation and features of histopathology photomicrography (Figure 4.9 and 10) slight blockage of vessels and macrophages in live and enlargement of hepatocytes. Sampled liver with sero-negatives camel six and seven had similar pathological lesions.

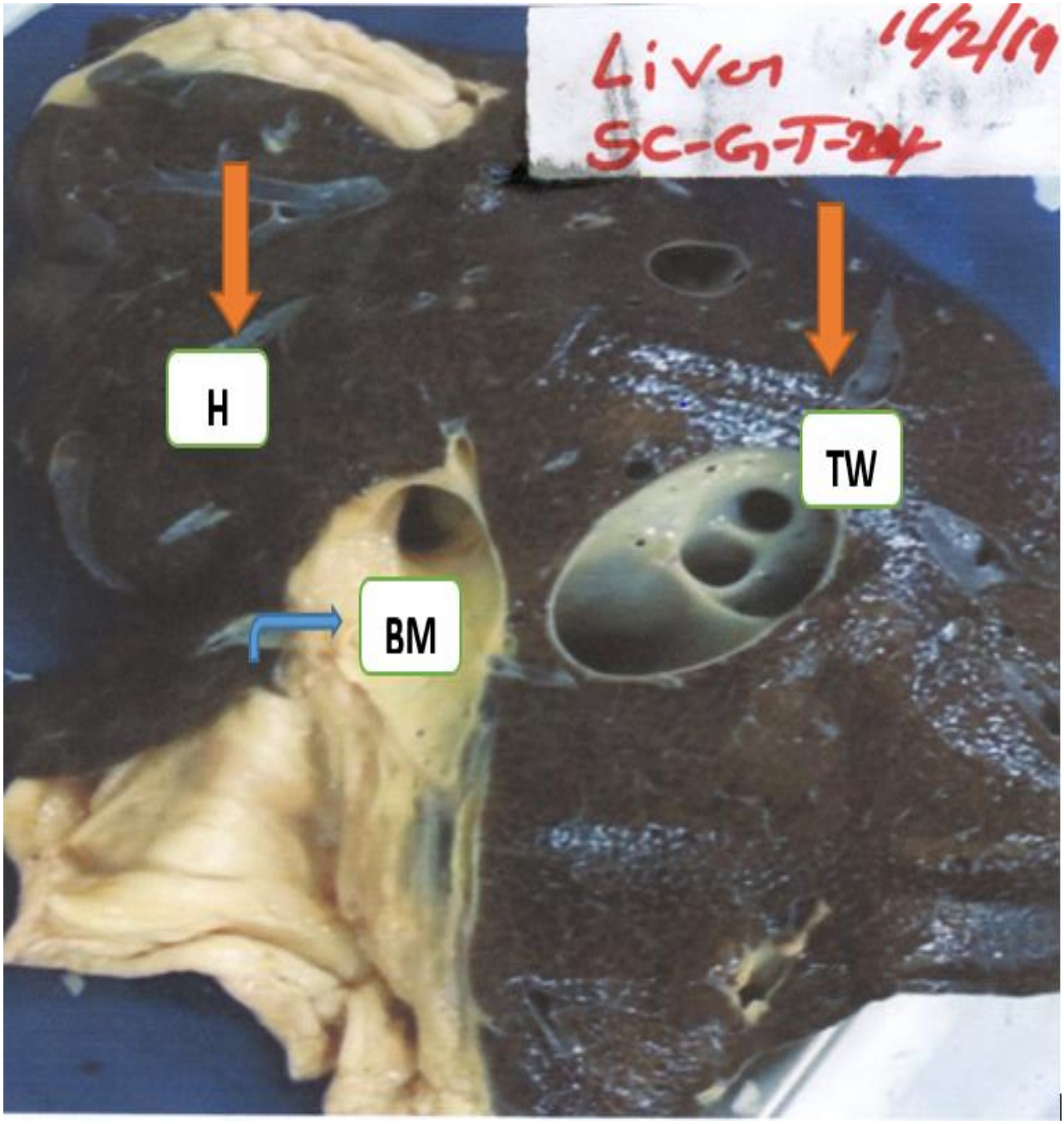


Figure 4.9: Condemned organ of liver with tested positive obtained from sample camel (SC-24) Showing hepatomegaly (H), thick walled of bile duct (TW), black materials in bile duct (BM).

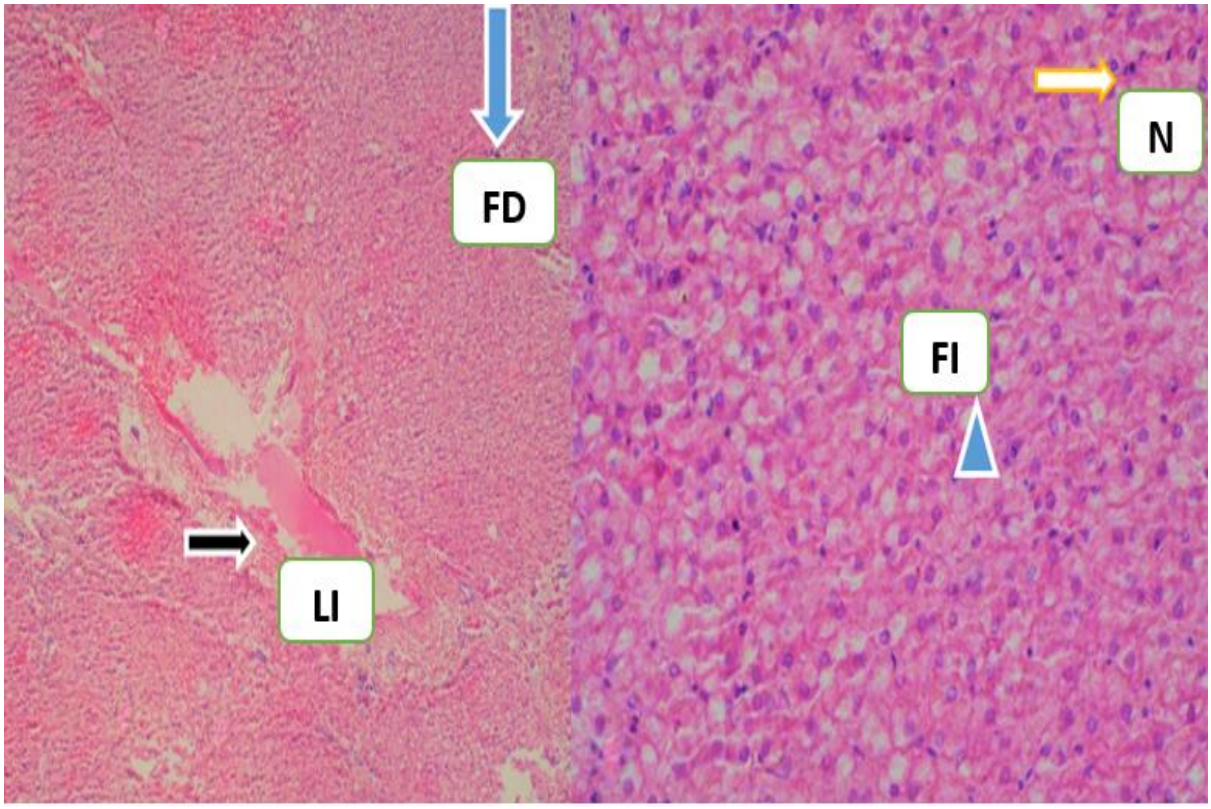


Figure 4.10: Histological section of condemned liver with tested seropositive obtained from sample camel Number (SC-24) showing fatty degeneration (FD), Neutrophils (N), liver injuries (LI), diffuse fatty infiltration (FI) and stained with (H/E).

4.3.4.5: kidney

The kidney tissue from seroposive camel brucellosis were shown diifernt pathological lesions lymphoblastic cells of infiltration,congestions and hemorhages in some arreas for gross and histopathology photomicrography (Figure: 4.11,12 and 13) and also there was inflamatory cells with the perodominantly hetrophils in kidneys. The other kidney sampled of seronegetive from number thirteen and seven had simillar pathological leisions.

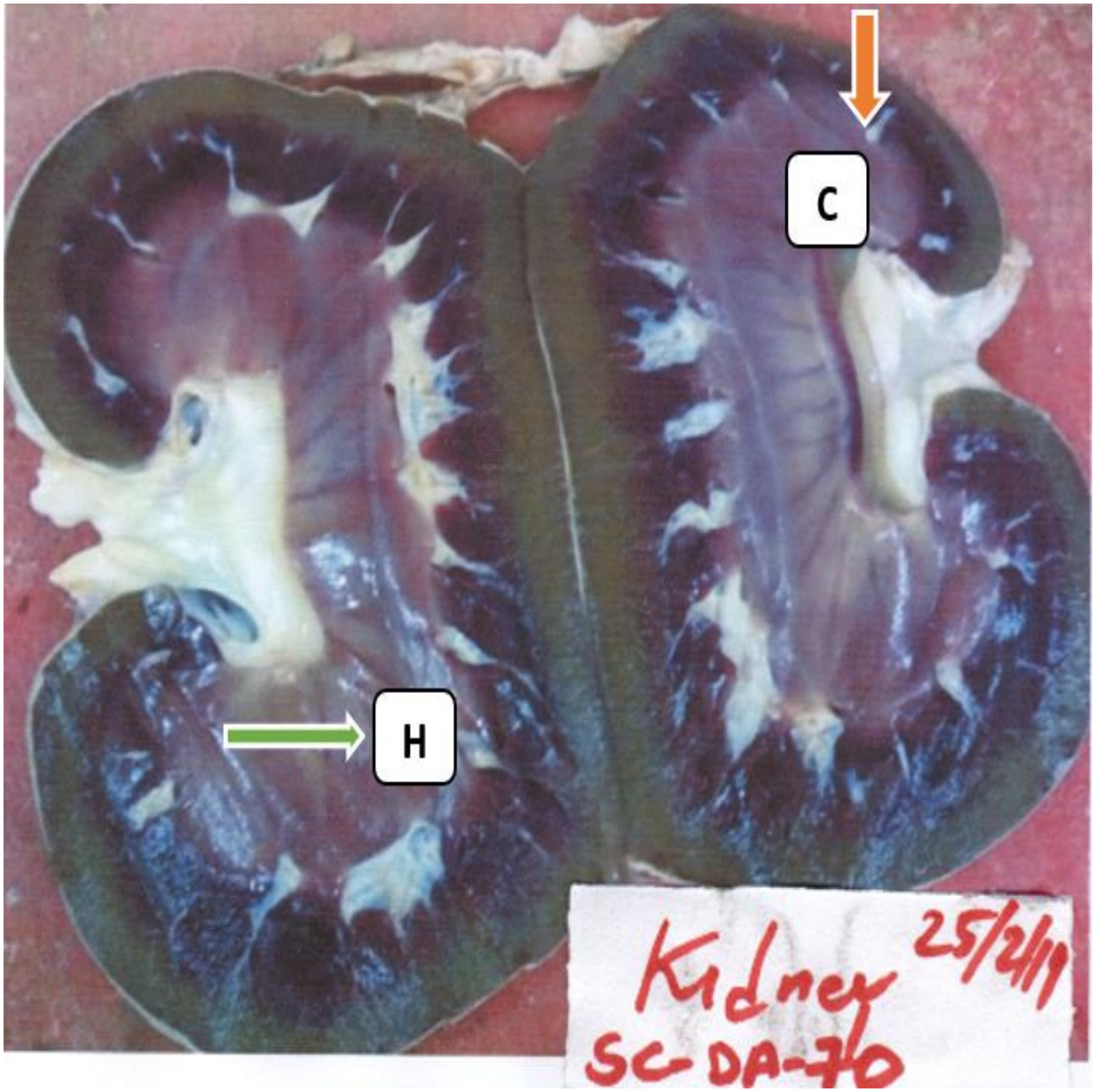


Figure 4. 11: Condemned organ of kidney with tested positive obtained from sample camel (SC-DA-70) Showing severe congestion(C) and haemorrhages (H).

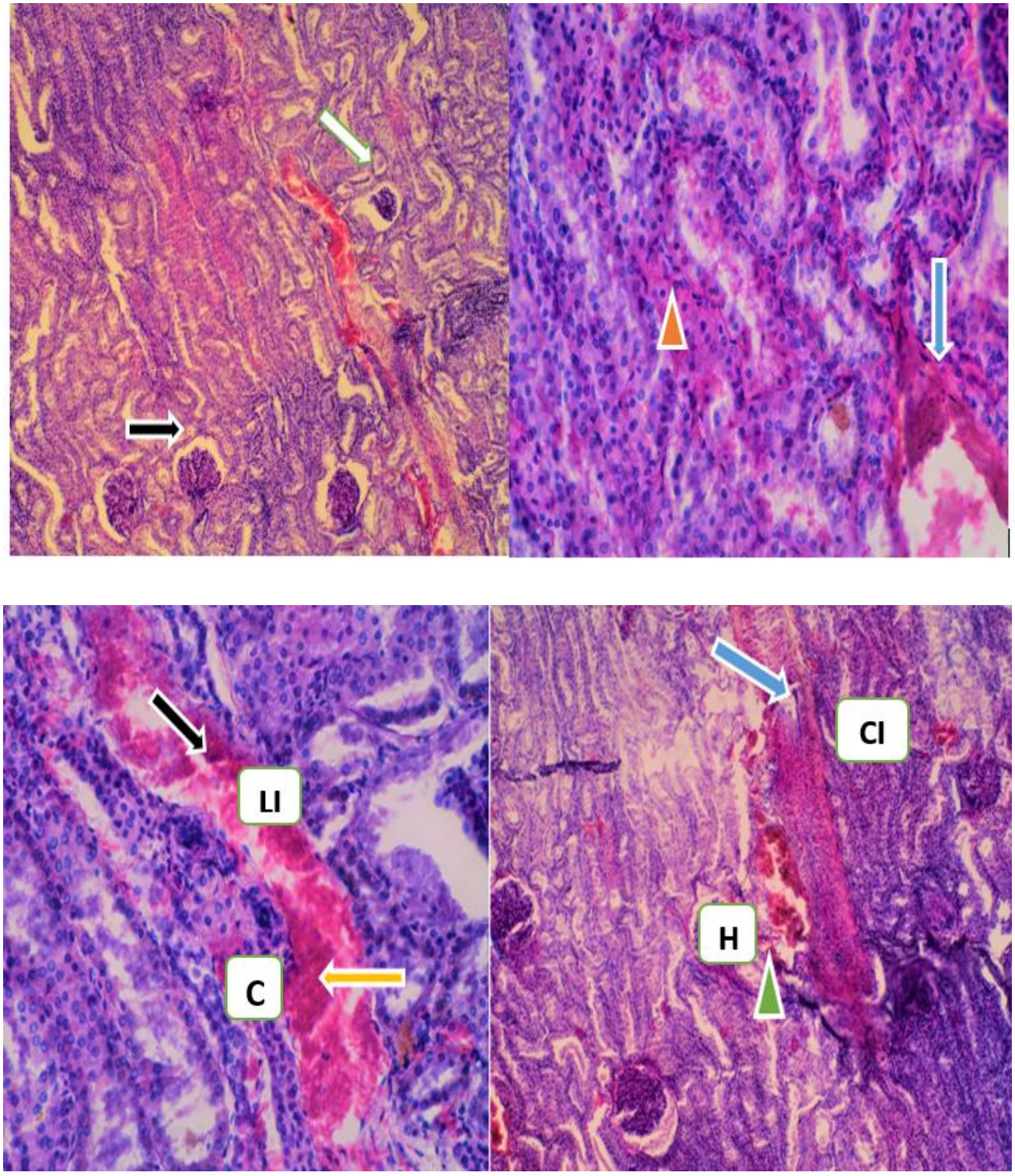


Figure 4. 12: Histlopathological features of kidney with tested seropositive obtained from sample camel numbe (SC-70) showing that lymphoblastic cells of infiltration (LI),congestions (C),cellulr infiltaraions (CI) and hemorhages (H) which is stained with (H/E).

Therefore, the higher magnification photography of tested positive as demonstrated bellow showing severe congestion of kidney.

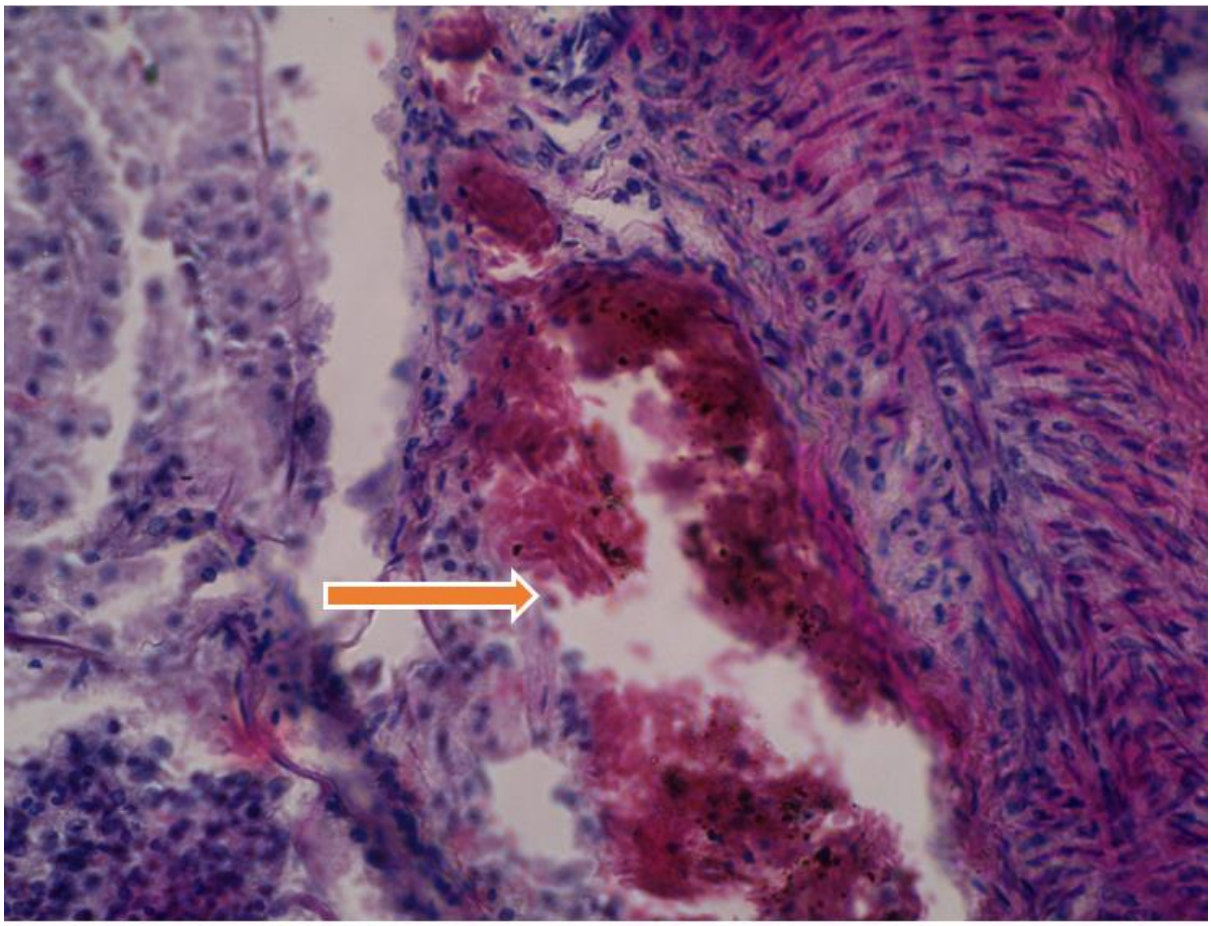


Figure 4.13: A higher magnification (X.400) with the same sample Tested Positive showing that the sever congestion in kidney and it stained with (H&E).

CHAPTER FIVE: DISCUSSIONS, CONCLUSION AND RECOMMENDATION

5.1: Discussions

The study was carried out camel slaughterhouses in Garissa so as to establish presence of brucellosis in camels by using serology and establishment of pathological lesions (gross and microscopic).

In determining, presence of *Brucella* antibodies of 160 camel samples were tested using Four (4) serological tests, namely: Rose Bengal Plate Test (RBPT), Serum Agglutination Test (SAT), Competitive Enzyme Linked Immuno Sorbent Assay (c-ELISA) and Double Agar Gel Immuno diffusion Test (AGID). This was because the tests were developed for testing cattle serum; this study was to find out if the tests can be used for camel serum and their respective sensitivities in picking *Brucella* antibodies in camel serum. The overall sero-prevalence (mean for the 4 tests) was found to be about 10% of (15-16/160). This is similar to what (Alhaji *et.al.* 2016).that found sero-prevalence of (10.6%). The 4 serological tests used were found not to be significantly different (chi square(x^2) .0999). However, the one that detected highest percentage of reactors was SAT (10%) followed by RRBPT and c-ELISA (9.3% each); lastly AGID (6.8%). Other researchers comparing these tests, in cattle/camel were found similarly (Shah, *et.al*, 2017).

5.1.1: study of Sero-prevalence

A total of one hundred and sixty (160) camel serum samples from Garissa slaughterhouses were confirmed by using Rose Bangle Plate Test (RBPT). Fifteen (15) samples (10%) tested positive. From Garissa-township (n=50) four (4) samples (8.0%) were tested positive, Fifty (n=50) samples from Dadaab slaughterhouses six (6) (12.0%) were tested positive while sixty (n=60) samples from Balambale slaughterhouses five (5) (8.3%) were tested positive. Similar findings was reported in Ethiopia (Gwida, *et.al*, 2012).

The one hundred and sixty (160) camel serum samples from Garissa County slaughterhouse were also tested by using serum agglutination test (SAT). Sixteen (16) samples (10.50%) were tested positive. From Garissa-township four (4) samples (8.0%) were tested positive. From Dadaab six (6) samples (12.0%) tested positive. From Balambale six (6) samples (10.0%) were tested positive. For the 16 positive samples 10 samples had a titre of 1/10, 3 samples a titre of 1/20, 2 samples attire of 1/40, and 2 sample had a titre of 1/80 and 3 samples had a titre of 1/160. Similar prevalence previously reported in Garissa and wajir (wanjohi, *et.al,* 2012).

The one hundred and sixty (160) had also tested using by Competitive Enzyme Linked Immune Sorbent Assay (c-ELISA). Fifteen (15) samples (9.3%) were tested positive. From Garissa-Township central of Garissa County (n=50), four (4) samples were tested positive. From Dadaab (n=50), five (5) samples had tested positive. For Balambale (n=60), six (6) samples were tested positive. As reported similarly (Njeru, *et al.* 2016). The one hundred and sixty (160) camel serum samples from Garissa slaughterhouses were also tested by using AGID Test. eleven (11) samples (6.8%) were tested positive. From Garissa-Township (n=50), two (2) sera samples (4.0%) were tested positive. From Dadaab (n=50), three (3) sera samples (6.0%), were tested positive. And from Balambale (n=60), six (6) sera samples had tested positive. Using chi-square ($\chi 2$), there was no statistical difference in sensitivity between the four serological tests (p=0.999). Similar findings was reported by (Salih, 2015).

The present study for sero-prevalence result findings (10%) is similar to the previous reports from the different countries (Junaidu, *et.al*, 2006; Dawood, 2008 and wanjohi *et.al*, 2012). However, there was lower than some studies in Somalia (Abbas and Agab, 2002), Somaliland (Ghanem, *et.al.* 2009), Tanzania (Assenga, *et.al,* 2015), and Ethiopia (Teshome, *et.al*, 2003), Nigeria (Junaidu, *et.al,* 2006 and Madu, *et.al,* 2016), in Saudi Arabia (Teshome, *et.al*, 2003), and Yemen (Al-Garadi, *et.al*, 2015).

Ser-prevalence was differed from other findings in neighbouring countries of Kenya (in the Afar region of Northeast Ethiopia (Hadush, *et.al,* 2013). Individually, in the lower sero-prevalence in this study is not consistence with the other prevalence findings which showed that the infection is more prevalence among nomadic slaughterhouses in Garissa county Kenya.

The sero-prevalence of *Brucellosis* in camel was lower in extensively kept pastoralists of camel in Garissa-township and Dadaab slaughterhouses, while on the other hand had been reported in intensively kept pastoralists of camel was higher in Balambale slaughterhouses. Thus several factors may affect increasing result of serological outcomes such as production system, overcrowding of restricted area, contacts between the animals, immune suppressive effective of Trypanosomiasis that often prevalence in camel and cross-reacting bacteria of *E-coli, Salmonella* and *Yersinia* and uses of lower specificity tests. These factors have potential effects for serological findings. As reported (Ali, *et.al,* 2013)

The sample sections and sampling for different animals may also be effect higher prevalence for the serology study. The higher prevalence of brucellosis represents the major challenges of both economics and public health problems. It is prospective that there is higher frequency of abortion/reproductive failures that may lead to the potential higher level of exposures of livestock owners and their families. It was very important to know that the RBPT is good diagnostic sensitivity compared to the other there (3) serological testes that have been done to the survey (Gessese *et.al,* 2014). So that, the RBPT is satisfactory screening test as (OIE: recommended in 2012) the test procedure for diagnosis of bovine brucellosis to be applied for camel brucellosis. The disease effect in camels are not known to be the host of *Brucella* organism, but it is well known to be susceptible for *Brucella abortus* and *Brucella melitensis*.

Therefore, the disease in wildlife and domestic animals is still remaining from the sources of human infection through, direct contacts and contamination of environment during parturition

and abortion. However, the infection in camel has been reported in Saudi Arabia, Sudan, Kenya, and Tanzania, Ethiopia and Somalia and other countries, therefore, to control of the disease both animals and man you need to keep the following: (1) improvising the hygiene (to reduce the direct contacts between infected and non-infected animals), (2) public awareness (to control and prevent the infection) and (3) proper disposal (to be disposed the effected foetus, tissues, discharges and poste-mortem equipment and to infect the contemned utensils) (Ali, *et.al*, 2013).

Therefore, this study has been confirmed the presence of brucellosis in Garissa slaughterhouses of Kenya showing that the significant of sero-prevalence of (10% tested with RBPT, SAT c-ELISA and AGID). Further studies are more needed to improve the production of camel and diminish the risk transmissions of the infection to the human especially benchers. There is also needed control program for brucellosis in camel slaughterhouses and other animals. Standard biosecurity measures at slaughterhouses and farms be enhanced to control and prevent of *Brucella* infection to animals and human.

5.1.2: Pathological lesions

The cross-sectional study 48% of slaughtered camel had one or more contaminations of organ at Garissa-township, Dadab and Balambale slaughterhouses. Up on histopathology the main causes of contamination apart from *Brucellosis* were: Circulatory disturbance, and inflammatory conditions.

The clinical manifestation of the slaughtered camel embraced swollen of lymph nodes (24%), sever lameness (30%) and abortion (5%). Therefore, according to the sero-reactant samples the highest clinical manifestation is lameness and the lowest is Abortion rather than other encountered clinical manifestations in the study. In the swollen of lymph nodes of the effected and non-effected of *Brucellosis* in slaughtered camels were enlarged and abscess that

attributed to obstruction and discolorations of fluid. Microscopically, due to the miss stained of the slide some area appeared disorganized, cellular infiltrations, mononuclear inflammatory cells, immunoblastic infiltrations, increase number of lymphocytes and hypoplasia meaning that(underdevelopment or incomplete development of a tissue or organ). These lesions there was similar study in camel lymph nodes that come across in Sudan (Aljameel, *et.al,* 2013) and in Yemen (Hamza, *et.al,* 2017). There is also another study that has been taken in the same author in different area and different year (Aljameel, *et.al,* 2014).

There is also liver of three (1.8%) obtained from the positive tested *Brucellosis* which had clinical manifestation of lameness at the anti-mortem record. In Histopathology, Fatty Degeneration, Diffuse of fatty infiltrations, fibrosis, hepatocyte denegation and in some area necrosis. Similar findings were reported in Iran (Khaniki, *et.al,* 2013) and in Saudi Arabia (Mohamed *et.al,* 2014). The adjusted area of the liver there was injury, congestion convoyed to inflammatory infiltrated cells and hepatocyte degenerations in some area. These grossly and histopathology findings generally decides with the study of (Khaniki, *et.al,* 2013 and Mohamed, *et.al,* 2014).

The lung of two (1.2%) from positive slaughtered camel was rejected at the slaughterhouses in Dadaab due to the enlargement, discoloration, white and red spots and fluid filed with cyst from the surface. Microscopically, collapse of alveoli, pinkish fluid materials with the alveoli (Oedema), mononuclear infiltrations of cells, slight blockage of vessels and macrophages, enlargement of hepatocyte cells .The adjacent area of bronchioles were congested a accompanied by slight inflammatory cells. Similar findings, were reported in a study in Saudi Arabia (Gameel and Yassein, 2010 and Beigh, *et.al*, 2017).

A heart from 4(2.5%) of tested positive *Brucellosis* that rejected to supply the slaughterhouses were condemned fibrins and haemorrhages. These gross condition were also met at the slaughterhouse. Histopathological examinations, fibrins and haemorrhages,

destructions of fibrins, lymphoblastic infiltrations, Macrophages and neutrophil infiltrations, fatty degenerations and inflammatory cells were found. Similar study has been done in Tanzania (Tembo, and Nonga, 2015); and in Bangladesh (Mazumder, *et.al*, 2012).

Kidney of 2(1.2%) from camel slaughtered were also condemned during the poste-mortem inspection as they were discoloured and congested and haemorrhages with white-dark-red under the renal cortex .microscopically, conformed that the presence of inflammation in cells, infiltration, macrophages, haemorrhages and congestion. Previous studies had also done from lung tissue of slaughtered camel in Athi River, Kenya (Mutua, *et.al*, 2017).

The lung from 2(1.2%) slaughtered camel obtained from sero-negative sample that were also condemned during the poste-mortem inspection with the red-dark coloured under pleural cavity.

These conditions were also come across at the slaughter. Histological examination, confirmed that presence of erythrocytes and pinkish materials in bronchi and bronchioles and there was symptoms indicating inflammation in the slaughtered camel lung. Similar study has done in Ethiopia with the absence of inflammatory cells in lung (Mamo, *et.al*, 2011).

Finally, there is correlation between the gross pathology and microscopically examination.

5.2: Conclusions

1. The sero-positivity demonstrated by the camel brucellosis brought-in for slaughter was about 10% this indicates that the disease is enzootic in the area, though the figure is lower than what has been reported in other areas of the county. The infection has both economic and public health importance; it is zoonotic. So that, according to the test results, Camels from Balambale slaughterhouses showed higher sero-positivity, using by the four (4) different serological test.
2. Camels that were sero-positive also had clinical and pathological lesions similar to those brucellosis. Therefore, there was correlation of the positive tested animal, clinical and pathological lesion that observed in the different test of the study.
3. There was a number of condemned organs due to the infectious and non-infectious that contributed by the sanitation levels of poor slaughtering of the animals such liver, lung and other visceral organs which is good for human consumption. And it was also taking parts to the economic losses of slaughterhouses in the county.

5.3: Recommendations

1. The animal owners and veterinarians in Garissa-County should make efforts by investigating any case of brucellosis as abortion and retained of placenta in their livestock farm/ Slaughterhouse that are included in their disease reports.
2. Although brucellosis is well known disease in the Garissa County, the pastoralists should not engage in practices that put them to higher risk exposure, thus there is a need to educate the public on proper handling of the animals especially those having the clinical and pathological lesions in slaughterhouses in the study area. Therefore, the brucellosis was endemic in Balambale, Garissa-township and Dadaab, so the control and prevention efforts should continuous through vaccination and other strategies of controls of the disease.
3. Further study should be carried out that involving the contribution of brucellosis to the pathological lesions in animals including wildlife to enhance understanding of prevalence, scope and the impact of the disease in slaughterhouses particularly camel slaughterhouses to the county and the country.

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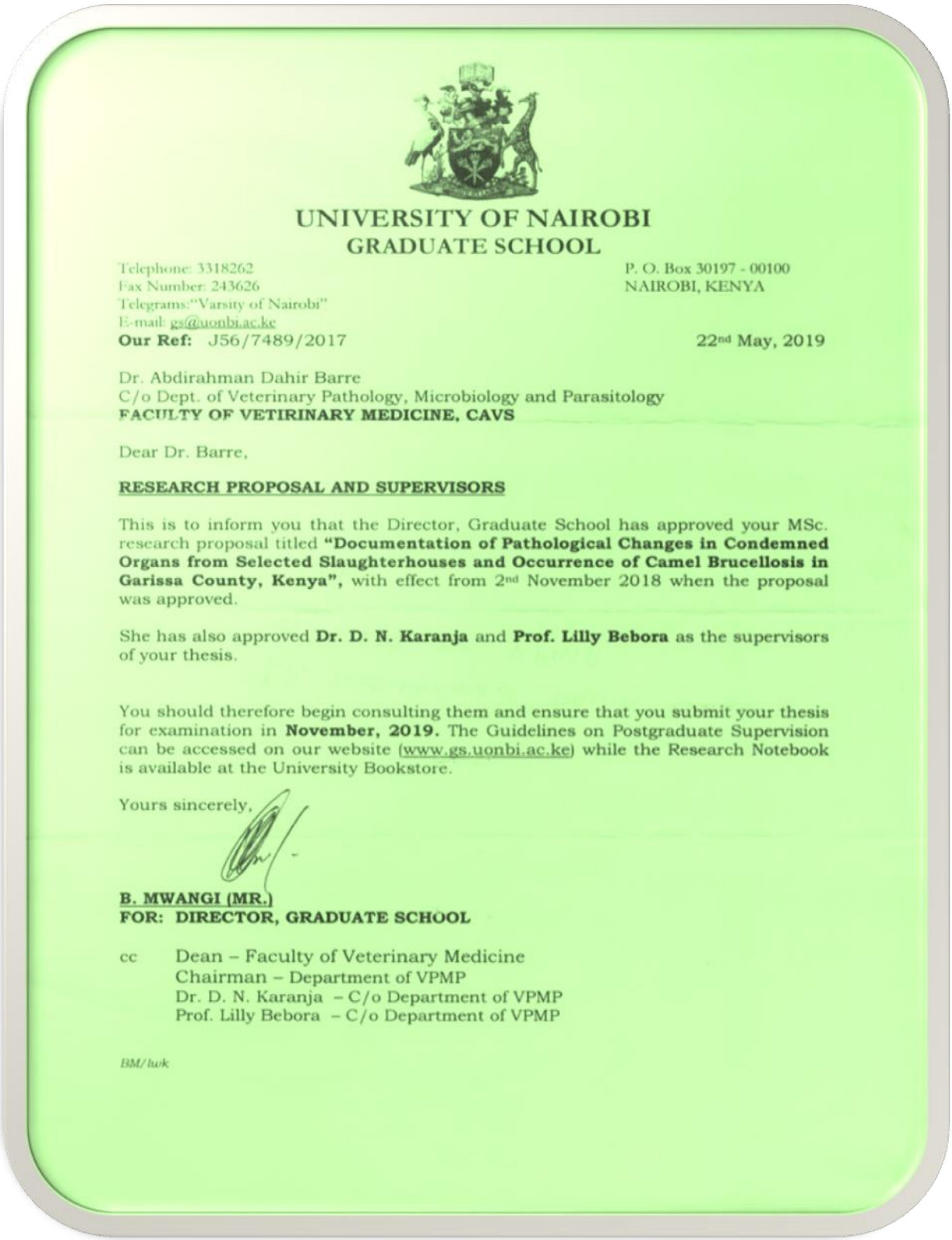
7.0: APPENDICES:

Appendix7. 1: Approval of research for graduate school of University of Nairobi (UoN)



UNIVERSITY OF NAIROBI
GRADUATE SCHOOL

Telephone: 3318262
Fax Number: 243626
Telegrams:"Varsity of Nairobi"
E-mail: gs@uonbi.ac.ke

P. O. Box 30197 - 00100
NAIROBI, KENYA

Our Ref: J56/7489/2017

22nd May, 2019

Dr. Abdirahman Dahir Barre
C/o Dept. of Veterinary Pathology, Microbiology and Parasitology
FACULTY OF VETIRINARY MEDICINE, CAVS

Dear Dr. Barre,

RESEARCH PROPOSAL AND SUPERVISORS

This is to inform you that the Director, Graduate School has approved your MSc. research proposal titled **"Documentation of Pathological Changes in Condemned Organs from Selected Slaughterhouses and Occurrence of Camel Brucellosis in Garissa County, Kenya",** with effect from 2nd November 2018 when the proposal was approved.

She has also approved **Dr. D. N. Karanja** and **Prof. Lilly Bebora** as the supervisors of your thesis.

You should therefore begin consulting them and ensure that you submit your thesis for examination in **November, 2019.** The Guidelines on Postgraduate Supervision can be accessed on our website (www.gs.uonbi.ac.ke) while the Research Notebook is available at the University Bookstore.

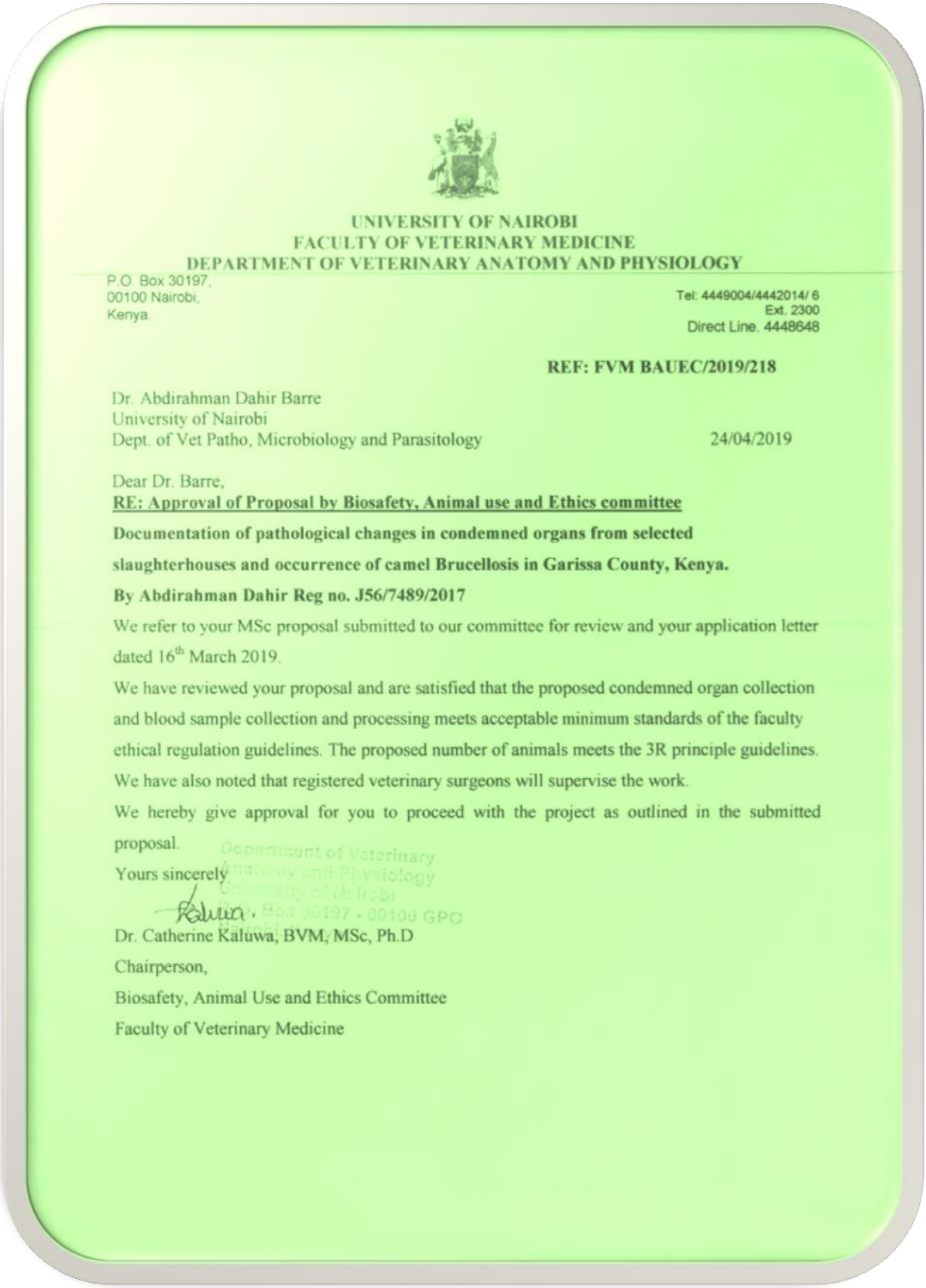
Yours sincerely,

B. MWANGI (MR.)
FOR: DIRECTOR, GRADUATE SCHOOL

cc Dean – Faculty of Veterinary Medicine
Chairman – Department of VPMP
Dr. D. N. Karanja – C/o Department of VPMP
Prof. Lilly Bebora – C/o Department of VPMP

BM/lwk

Appendix7. 2: Approval of proposal by biosafety, animal use and ethics committee



UNIVERSITY OF NAIROBI
FACULTY OF VETERINARY MEDICINE
DEPARTMENT OF VETERINARY ANATOMY AND PHYSIOLOGY

P.O. Box 30197,
00100 Nairobi,
Kenya.

Tel: 4449004/4442014/ 6
Ext. 2300
Direct Line. 4448648

REF: FVM BAUEC/2019/218

Dr. Abdirahman Dahir Barre
University of Nairobi
Dept. of Vet Patho, Microbiology and Parasitology

24/04/2019

Dear Dr. Barre,

RE: Approval of Proposal by Biosafety, Animal use and Ethics committee

Documentation of pathological changes in condemned organs from selected slaughterhouses and occurrence of camel Brucellosis in Garissa County, Kenya.

By Abdirahman Dahir Reg no. J56/7489/2017

We refer to your MSc proposal submitted to our committee for review and your application letter dated 16th March 2019.

We have reviewed your proposal and are satisfied that the proposed condemned organ collection and blood sample collection and processing meets acceptable minimum standards of the faculty ethical regulation guidelines. The proposed number of animals meets the 3R principle guidelines. We have also noted that registered veterinary surgeons will supervise the work.

We hereby give approval for you to proceed with the project as outlined in the submitted proposal.

Yours sincerely

Department of Veterinary Anatomy and Physiology University of Nairobi P.O. Box 30197 - 00100 GPO Nairobi

Dr. Catherine Kaluwa, BVM, MSc, Ph.D
Chairperson,
Biosafety, Animal Use and Ethics Committee
Faculty of Veterinary Medicine

Appendix7. 3: Approval from County Director of Veterinary Services –Garissa County Kenya

REPUBLIC OF KENYA
MINISTRY OF AGRICULTURE, LIVESTOCK, COOPERATIVE AND FISHERIES GARISSA COUNTY
COUNTY DIRECTOR OF VETERINARY SERVICES

GSA/CDVS/TRAINING/1/18

P.O BOX 295
GARISSA
23rd May 2019

ABDIRAHMAN DAHIR BARRE
(J56/7489/2017)

RE: AUTHORIZATION OF RESEARCH PROJECT (MASTER OF SCIENCEIN VETERINARY PATHOLOGY AND DIAGNOSTICS)

Your research on contribution of Brucellosis to pathological lesions leading to condemnation of organs in camels from selected slaughterhouse in Garissa county, Kenya from 4th Jue2018-13th July 2018 at Garissa slaughter house refers.

This office has no objection for you to conduct the research in Garissa county slaughterhouse. The officer in charge of the slaughterhouse is hereby requested to provide the necessary support.

COUNTY DIRECTOR VETERINARY SERVICES GARISSA Date 23/5/2019

Dr.Jackson Kinyua

County Director Veterinary services

CC
The Chief officer livestock development

The sub county veterinary officer,Garissa

Appendix 7.4: Serology test result from different study area and four different test in the study

SH. No:	Samples No:	SM-ID:	Location	Result in RBPT	Result in SAT	Result in c-ELISA	Result- in DGD
I.	1-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
I.	2-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
I.	3-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
I.	4-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
I.	5-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
I.	6-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
I.	7-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
I.	8-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
I.	9-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
I.	10-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
I.	11-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
I.	12-	SC-GT	G-township	+Ve	+Ve	+Ve	+Ve
I.	13-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
II.	14-	SC-GT	G-township	+Ve	+Ve	+Ve	+Ve
II.	15-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
II.	16-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
II.	17-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
II.	18-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
II.	19-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
II.	20-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
II.	21-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
II.	22-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
II.	23-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
II.	24-	SC-GT	G-township	+Ve	+Ve	+Ve	+Ve
II.	25-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve

SH. No:	Samples No:	SM-ID:	Location	Result in RBPT	Result in SAT	Result in c-ELISA	Result- in DGD
II.	26-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
III.	27-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
III.	28-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
III.	29-	SC-GT	G-township	+Ve	+Ve	+Ve	+Ve
III.	30-	SC-GT	G-township	+Ve	+Ve	+Ve	+Ve
III.	31-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
III.	32-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
III.	33-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
III.	34-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
III.	35-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
IV.	36-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
IV.	37-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
IV.	38-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
IV.	39-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
IV.	40-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
IV.	41-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
IV.	42-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
IV.	43-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
IV.	44-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
IV.	45-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
IV.	46-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
IV.	47	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
IV.	48-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
IV.	49-	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
IV.	50-`	SC-GT	G-township	-Ve	-Ve	-Ve	-Ve
V.	51-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve

SH. No:	Samples No:	SM-ID:	Location	Result in RBPT	Result in SAT	Result in c-ELISA	Result- in DGD
V.	52-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
V.	53-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
V.	54-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
V.	55-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
V.	56-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
V.	57-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
V.	58-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
V.	59-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
V.	60-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
V.	61-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
V.	62-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
V.	63-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
V.	64-	SC-DH	Dadaab	+Ve	+Ve	+Ve	+Ve
V.	65-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
V.	66-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
V.	67-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
V.	68-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
V,	69-	SC-DH	Dadaab	+Ve	+Ve	+Ve	+Ve
V.	70-	SC-DH	Dadaab	+Ve	+Ve	+Ve	+Ve
VI.	71-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VI.	72-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VI.	73-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VI.	74-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VI.	75-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VI.	76-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VI.	77-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve

SH. No:	Samples No:	SM-ID:	Location	Result in RBPT	Result in SAT	Result in c-ELISA	Result- in DGD
VI.	78-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VI.	79-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VI.	80-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VI.	81-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VI.	82-	SC-DH	Dadaab	-Ve-	-Ve	-Ve	-Ve
VI.	83-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VI.	84-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VI.	85-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VI.	86-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VI.	87-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VI..	88-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VII.	89-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VII.	90-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VII.	91-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VII.	92-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VII.	93-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VII.	94-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VII.	95-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VII.	96-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VII.	97-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VII.	98-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VII.	99-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VII.	100-	SC-DH	Dadaab	-Ve	-Ve	-Ve	-Ve
VII.	101-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
VII.	102-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
VII.	103-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve

SH. No:	Samples No:	SM-ID:	Location	Result in RBPT	Result in SAT	Result in c-ELISA	Result- in DGD
VII.	104-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
VII.	105-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
VIII.	106	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
VIII.	107-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
VIII.	108-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
VIII..	109-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
VIII.	110-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
VIII.	111-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
VIII.	112-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
VIII.	113-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
VIII.	114-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
VIII.	115-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
VIII.	116-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
VIII.	117-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
VIII.	118-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
VIII.	119-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
VIII.	120-	SC-BA	Balambale	+Ve	+Ve	+Ve	+Ve
IX.	121-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
IX.	122-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
IX.	123-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
IX.	124-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
IX.	125-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
IX.	126-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
IX.	127-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
IX.	128-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
IX.	129-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve

SH. No:	Samples No:	SM-ID:	Location	Result in RBPT	Result in SAT	Result in c-ELISA	Result- in DGD
IX.	130-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
X.	131-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
X.	132-	SC-BA	Balambale	+Ve	+Ve	+Ve	+Ve
X.	133-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
X.	134-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
X.	135-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
X.	136-	SC-BA	Balambale	-Ve	+Ve	-Ve	-Ve
X.	137-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
X.	138-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
X.	140-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
XI.	141-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
XI.	142-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
XI.	143-	SC-BA	Balambale	+Ve	+Ve	+Ve	-Ve
XI.	144-	SC-BA	Balambale	+Ve	+Ve	+Ve	-Ve
XI.	145-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
XI.	146-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
XII.	147-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
XII.	148-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
XII.	149-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
XII.	150-	SC-BA	Balambale	+Ve	+Ve	+Ve	-Ve
XII.	151-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
XII.	152-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
XIII.	153-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
XIII.	154-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
XIII.	155-	SC-BA	Balambale	+Ve	+Ve	+Ve	-Ve
XIII.	156-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve

SH. No:	Samples No:	SM-ID:	Location	Result in RBPT	Result in SAT	Result in c-ELISA	Result- in DGD
XIII.	157-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
XIII.	158-	SC-BA	Balambale	+Ve	+Ve	+Ve	-Ve
XIII.	159-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve
XIII.	160-	SC-BA	Balambale	-Ve	-Ve	-Ve	-Ve

GT: Garissa-township

DH: Dadaab

BA: Balambale

SC: sample camel

+Ve: Positive

RBPT: Rose Bangle Plate Test

SAT: Serum Agglutination Test

c-ELISA: Competitive Enzyme Linked Immuno Sorbent Assay

DAG: T Double Ager Gel Test

-Ve: Negatives

Appendix7.5: c-ELISA test set-up

Plate one	1	2	3	4	5	6	7	8	9	10	11	12
A	T	T	T	T	T	T	T	T	T	T	+	+
B	T	T	T	T	T	T	T	T	T	T	+	+
C	T	T	T	T	T	T	T	T	T	T	+	+
D	T	T	T	T	T	T	T	T	T	T	C	C
E	T	T	T	T	T	T	T	T	T	T	C	C
F	T	T	T	T	T	T	T	T	T	T	-	-
G	T	T	T	T	T	T	T	T	T	T	-	-
H	T	T	T	T	T	T	T	T	T	T	-	-

Plate Two	1	2	3	4	5	6	7	8	9	10	11	12
A	T	T	T	T	T	T	T	T	T	T	+	+
B	T	T	T	T	T	T	T	T	T	T	+	+
C	T	T	T	T	T	T	T	T	T	T	+	+
D	T	T	T	T	T	T	T	T	T	T	C	C
E	T	T	T	T	T	T	T	T	T	T	C	C
F	T	T	T	T	T	T	T	T	T	T	-	-
G	T	T	T	T	T	T	T	T	T	T	-	-
H	T	T	T	T	T	T	T	T	T	T	-	-

Plate three	1	2	3	4	5	6	7	8	9	10	11	12
A	T	T	T	T	T	T	T	T	T	T	+	+
B	T	T	T	T	T	T	T	T	T	T	+	+
C	T	T	T	T	T	T	T	T	T	T	+	+
D	T	T	T	T	T	T	T	T	T	T	C	C
E	T	T	T	T	T	T	T	T	T	T	C	C
F	T	T	T	T	T	T	T	T	T	T	-	-
G	T	T	T	T	T	T	T	T	T	T	-	-
H	T	T	T	T	T	T	T	T	T	T	-	-

Plate Four	1	2	3	4	5	6	7	8	9	10	11	12
A	T	T	T	T	T	T	T	T	T	T	+	+
B	T	T	T	T	T	T	T	T	T	T	+	+
C	T	T	T	T	T	T	T	T	T	T	+	+
D	T	T	T	T	T	T	T	T	T	T	C	C
E	T	T	T	T	T	T	T	T	T	T	C	C
F	T	T	T	T	T	T	T	T	T	T	-	-
G	T	T	T	T	T	T	T	T	T	T	-	-
H	T	T	T	T	T	T	T	T	T	T	-	-

T= Test samples

C= conjugate

+=Positive control

-=Negative control

Appendix7.6: c-ELISA test set-up

Plate one	1	2	3	4	5	6	7	8	9	10	11	12
A	0.75	0.71	0.70	0.84	0.71	0.53	0.32	0.33	0.90	0.91	+	+
B	0.77	0.75	0.70	0.77	0.73	0.68	0.48	.45	0.92	0.93	+	+
C	0.75	0.79	0.54	0.53	0.79	0.68	0.54	0.56	0.93	0.43	+	+
D	0.80	0.66	0.23	0.21	0.79	0.59	0.90	0.86	0.56	0.65	C	C
E	0.77	0.63	0.72	0.82	0.72	0.91	0.67	0.76	0.67	0.65	C	C
F	0.76	0.79	0.72	0.82	0.48	0.42	0.90	0.59	0.43	0.45	-	-
G	0.51	0.40	0.74	0.67	0.21	0.23	0.26	0.24	0.67	0.58	-	-
H	0.53	0.79	0.50	0.43	0.90	0.98	0.54	0.67	0.89	0/89	-	-

Plate two	1	2	3	4	5	6	7	8	9	10	11	12
A	0.92	0.74	0.80	0.85	0.76	0.82	0.84	0.72	0.79	0.65	+	+
B	0.83	0.80	0.55	0.45	0.57	0.84	0.57	0.84	0.74	0.86	+	+
C	0.74	0.81	0.74	0.81	0.62	0.61	0.27	0.74	0.86	0.83	+	+
D	0.61	0.27	0.21	0.76	0.86	0.83	0.71	0.53	0.53	0.41	C	C
E	0.34	0.35	0.56	0.56	0.45	0.76	0.89	0.78	0.89	0.78	C	C
F	0.43	0.43	0.45	0.43	0.54	0.55	0.54	0.54	0.67	0.65	-	-
G	0.21	0.22	0.78	0.79	0.95	0.98	0.84	0.85	0.34	0.76	-	-
H	0.56	0.56	0.67	0.76	0.54	0.76	0.67	0.78	0.78	0.67	-	-

Plate three	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
A	0.83	0.62	0.66	0.72	0.66	0.53	0.78	0.75	0.70	0.78	+	+
B	0.62	0.45	0.46	0.68	0.53	0.71	0.75	0.73	0.74	0.98	+	+
C	0.66	0.57	0.58	0.42	0.48	0.65	0.56	0.63	0.66	0.61	+	+
D	0.45	0.53	0.59	0.60	0.64	0.21	0.22	0.78	0.98	0.78	**C**	**C**
E	0.51	0.52	0.56	0.57	0.78	0.98	0.12	0.11	0.83	0.84	**C**	**C**
F	0.57	0.70	0.74	0.83	0.60	0.43	0.44	0.69	0.62	0.86	-	-
G	0.82	0.90	0.63	0.67	0.72	0.57	0.65	0.60	0.62	0.57	-	-
H	0.39	0.35	0.13	0.16	0.77	0.76	0.51	0.36	0.51	0.25	-	-

Plate four	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
A	0.25	0.82	0.78	0.64	0.74	0.80	0.82	0.62	0.86	0.71	+	+
B	0.71	0.61	0.75	0.79	0.80	0.78	0.51	0.51	0.54	0.51	+	+
C	0.76	0.82	0.67	0.73	0.77	0.91	0.24	0.22	0.77	0.67	+	+
D	0.56	0.51	0.62	0.72	0.51	0.32	0.69	0.74	0.76	0.71	**C**	**C**
E	0.52	0.43	0.82	0.77	0.74	0.65	0.60	0.47	0.50	0.40	**C**	**C**
F	0.86	0.82	0.77	0.67	0.64	0.65	0.50	0.40	0.80	0.88	-	-
G	0.86	0.66	0.84	0.83	0.63	0.64	0.79	0.68	0.57	0.49	-	-
H	0.87	0.81	0.80	0.75	0.74	0.66	0.65	0.55	0.65	0.68	-	-

C- Conjugate Control

+: Positive Control

-: Negative Control

Appendix 7.7: Interim record sheet for the Slaughterhouses

UNIVERSITY OF NAIROBI
COLLEGE OF AGRICULTURE AND VETERINARY SCIENCES
FACULTY OF VETERINARY MEDICINE
DEPARTMENT OF VETERINARY PATHOLOGY, MICROBIOLOGY & PARASITOLOGY

Serial number ----------Date: ------/--------/-------

A. INTRODUCTION

Name: Dr.Abdirahman Dahir Barre, Student at University of Nairobi

Project Name: CAMEL BRUCELLOSIS: SERO-PREVALLANCE AND PATHOLOGICAL LESIONS AT SLAUGHTERHOUSES OF GARISSA COUNTY KENYA

Propose of interim record: to request documentation of the sero-prevalence and respective pathological lesions of camel brucellosis to help the above project titled.

B. BACKGROUND INFORMATION

Camel ID: ----------Date: ----------/---------/----------
Species ----------breed ----------sex ----------age----------Others--------

Owner ----------Address ----------telephone number----------

What is the name of your slaughterhouses? ----------for how long have operated it?

Which animals do you normally slaughter

C. CLINICAL AND GROSS PATHOLOGICAL LESIONS

Sample ID: ----------Date: ----------/---------/----------
--
Lesions ----------Body conditions ----------Good ----------

--poor ----------Organ Size ----------colour ----------

--------others ----------Liver---------- colour ----------others --

----------lung ----------colour ----------

-----others ----------Kidney---------- colour ---------- --------others ----------
D. Tissue sampled for histopathology (Choose the corrected sampled)
Lymph nodes ---------- Liver ---------- Lung ---------- Kidney ---------- Heart : ---------- Other tissue sampled :---------- ----------
E. CONCLUSION
• Laboratory Request • Histopathology
From the clinical and gross pathological lesions taken to histopathology

Appendix 7.8: clinical manifestations showing encountered from different slaughtered camel in Garissa County.

Clinical symptoms	**Slaughterhouses**			Total (%)
	Garissa-township	Dadaab	Balambale	
Lameness	11	15	21	47(29.3)
Placental infection	**2**	**1**	**3**	6(3.7)
Anorexia	1	1	4	6(3.7)
Abdominal pain	2	1	4	7(4.3)
Abortion	1	2	5	8(5.0)
Inflammation of testes	2	1	3	6(3.7)
Swollen of lymph nodes	8	12	19	39(24.3)
In appetence	2	2	3	7(4.3)
Decreases milk yield	1	1	5	7(4.3)
Epididymitis	2	2	2	6(3.7)
Infertility	2	1	4	7(4.3)
Weight loss	1	0	0	1(0.6)
Infection of urogenital	2	1	4	7(4.3)
Orchitis	1	2	3	6(3.7)
Total:	**38**	**42**	**80**	**160**

Appendix 7.9: Gross Pathological lesions showing in different Slaughterhouse.

Gross pathology lesions	**Slaughterhouses**			Total (%)
	Garissa-township	Dadaab	Balambale	
Fibrin depositions	2	1	4	7 (4.3)
Enlargement of lung	1	2	3	6 (3.7)
Abscess of lymph nodes	1	1	1	3 (1.8)
Congestion	3	1	4	8 (5.0)
Hepatomegaly	19	26	34	79(49.3)
Haemorrhages	1	2	3	6 (3.7)
Enteritis	3	2	5	10 (6.2)
Pericarditis	8	13	17	38 (23.7)
Emaciations	1	1	1	3 (1.8)

Appendix 7.10: Camel Slaughterhouse capture sheet

Name of the slaughterhouse----------county ----------
sub-county----------location ----------

Camel ID: ----------sex----------breed----------
organ ----------lesions----------
Gross pathological lesions ----------

Organs description	**Lymph nodes**	**Liver**	**Kidney**	**Lung**	**Heart**	**Skin**
Condemned organs						
Collected samples						
Tested samples						
Tested positive						
Tested negatives						
Clinal manifestations						
Gross lesions						
Laboratory test						
RBPT results						
c-ELISA Results						
SAT Results						
Double Gel Test Results						

Appendix 7.11: Clinical, gross pathological and histopathological lesions of study results with the positive and negative tested camels at slaughter

SH. No	Sub-county	Samples	Result	Organs	Clinical signs	Gross lesions	Histopathology
I	G-Township	SC-GT-1	Negative	Lymph nod	Enragement, swollen	Fibrins, deposition and discoloration	Lymphoblastic infiltration
I.	G-Township	SC-GT-2	Negative	Lymph node	Abscess and swollen	Purulent Fluids, white and red spots	Mononucleosis and Mature lymphocytes
I.	G-Township	SC-GT-3	Negative	Lymph node	Fever, swelling	Abscess and enlargement	Necrosis the areas are eosinophilia at (40x) and lymphocytes(100x)
I.	G-Township	SC-GT-4	Negative	Lymph node	Lymphadenitis, and inflammation	Fibrous and some wet areas to the lymph node	inflammatory and neutrophils in some areas
I.	G-Township	SC-GT-5	Negative	Lymph node	Swelling for the size	Purulent Fluids, white and red spots	Mature lymphocytes
I.	G-Township	SC-GT-6	Negative	Lymph node	Enlarged and fever	Abscess and swelling	Lymphoblastic and lymphocyte infiltration
I.	G-Township	SC-GT-7	Negative	Liver	Change in colour	Congestion and haemorrhagic	Inflammatory cells and infiltration
I.	G-Township	SC-GT-8	Negative	Liver	Nodules and fibrins	Discolorations congestion and haemorrhages	Inflammatory cells of infiltration in liver
I.	G-Township	SC-GT-9	Negative	Lung	White and red spots	Enlargement and congestion	Oedema and emphysema
I.	G-Township	SC-GT-10	Negative	Lung	Change in colour	Congestion and haemorrhages	Oedema and neutrophils in some arrears
I.	G-Township	SC-GT-11	Negative	Lung	Fibrin red spots	Congestion and haemorrhages	Oedema and collapse of alveoli
I.	G-Township	SC-GT-12	Positive	Lymph node stomach	Swollen in lymph nodes and fibrosis in intestines	Enlargement and abscess in lymph nodes and white and black area in intestine	Generally Lymph plastic infiltrations

SH. No	Sub-county	Samples	Result	Organs	Clinical signs	Gross lesions	Histopathology
II.	G-Township	SC-GT-13	Negative	Lung	Black spots of colour	Congestion and haemorrhages	Neutrophils in bronchi and infiltrations
II.	G-Township	SC-GT-14	Positive	Liver	White and red collard	Coagulation abnormalities, and ascites.	Enlargement of hepatocytes and focal area of infiltration
II.	G-Township	SC-GT-15	Negative	Liver	Red and white spots in liver	Red and discoloration	Mononuclear cells and thickened of bile duct
II.	G-Township	SC-GT-16	Negative	Lung	Abortion and infertility	Congestion	Break down in centre of alveoli
II.	G-Township	SC-GT-17	Negative	Liver	Retained of placentas	Haemorrhages	Faecal area infiltration
II.	G-Township	SC-GT-18	Negative	Kidney	Swollen of sub cutaneous (skin	Enteritis and emaciations	Acute tubular necrosis
II.	G-Township	SC-GT-19	Negative	Kidney	Decreased milk yield	infectious bronchitis	Congestion and mononuclear infiltrations
II.	G-Township	SC-GT-20	Negative	Kidney	Decreased milk yield	swelling and congestion	Congestion
II.	G-Township	SC-GT-21	Negative	Kidney	Emaciated of the animal	haemorrhages and congestion	haemorrhages and oedematous
II.	G-Township	SC-GT-22	Negative	Small intestine	Emaciated of the animal	Haemorrhagic fluids in body cavity	haemorrhages and congestion
II.	G-Township	SC-GT-23	Negative	small intestine	Emaciated of the animal	Fluids in foci and congestion	Mild mononuclear and congestion
II.	G-Township	SC-GT-24	Positive	Small intestine	Fibrins and degeneration	Fluids in foci and congestion	Infiltration of nonnuclear
II.	G-Township	SC-GT-25	Negative	Small intestine	Fibrins and degeneration	Fluids in foci and congestion	Mild mononuclear infiltration
III.	G-Township	SC-GT-26	Negative	Spleen	Splenomegaly	Enlarged and congested	Congestion and haemorrhages
III.	G-Township	SC-GT-27	Negative	Spleen	Splenomegaly	Enlarged and congested	Congestion and haemorrhages

SH. No	Sub-county	Samples	Result	Organs	Clinical signs	Gross lesions	Histopathology
III.	G-Township	SC-GT-28	Negative	Spleen	Splenomegaly	Enlarged and congested	Haemorrhages and congestion
III.	G-Township	SC-GT-29	Positive	Spleen	Splenomegaly	Enlarged and congested	Congestion
III.	G-Township	SC-GT-30	Positive	Spleen	Enragement of spleen	Enlarged and congested	haemorrhages
III.	G-Township	SC-GT-31	Negative	Skin	Puncture wounds,	Inflammation	Congestions and edam in some arrears
III.	G-Township	SC-GT-32	Negative	Skin	Infection	Inflammation	Congestions and edam
III.	G-Township	SC-GT-33	Negative	Skin	Abscesses and infection	Congestions and oedema	Cellular infiltrations
III.	G-Township	SC-GT-34	Negative	Skin	Wounds	No gross lesions	Not lesions
IV.	G-Township	SC-GT-35	Negative	Skin	Wounds	No gross lesions	No lesions
IV.	G-Township	SC-GT-36	Negative	Heart	Shortness of breath	Congested	Damaged tubular of blood vessels
IV.	G-Township	SC-GT-37	Negative	Heart	Anaemic and emaciations	haemorrhages	Empty spaces
IV.	G-Township	SC-GT-38	Negative	Heart	Anorexia	Red and white spots	Fat tissues can be seen
IV.	G-Township	SC-GT-39	Negative	Heart	Less walking	haemorrhages and oedema	Empty spaces and congestions
IV.	G-Township	SC-GT-40	Negative	Heart	Pneumonic	Fibrous and red spots	Congestion
IV.	G-Township	SC-GT-41	Negative	Liver	Jaundiced	Congested	Necrosis and congestion
IV.	G-Township	SC-GT-42	Negative	Liver	Anorexia, and vomiting,	Vascular degenerative changes	Congestion and necrosis
IV.	G-Township	SC-GT-43	Negative	Liver	Diarrhoea, weight loss, and fever.	haemorrhages and congestion	Enlargements of hepatocytes
IV.	G-Township	SC-GT-44	Negative	Lung	Blue colour around the lips	Enlarged and congested	Thickened of alveoli wells
IV.	G-Township	SC-GT-45	Negative	Lung	Cyanosis	Enlarged and congested	Interstitial mononuclear infiltrations
IV.	G-Township	SC-GT-46	Negative	Lymph nods	Swollen	Swollen and abscess	Lymphocytes with immunoplasts

SH. No	Sub-county	Samples	Result	Organs	Clinical signs	Gross lesions	Histopathology
IV.	G-Township	SC-GT-47	Negative	Lymph node	Abscesses	abscess and fluids	Prominent of nuclei
IV.	G-Township	SC-GT-48	Negative	Lymph node	Enlarged	Change in colour	Lymphocytic infiltrations
IV.	G-Township	SC-GT-49	Negative	Lymph node	Swollen	Enlargement and swollen	Basophilic in vascular nuclei
V.	G-Township	SC-GT-50	Negative	Lymph node	Enlarged	abscess and fluids	Prominent of nuclei
V.	Dadaab	SC-DH-51	Negative	Skin	dry and hard,	Acanthosis (epidermal hyperplasia)	Inflammatory cell infiltration
V.	Dadaab	SC-DH-52	Negative	Skin	Emaciated	Amyloids in dermis	Deposition of foreign substances
V.	Dadaab	SC-DH-53	Negative	Skin	Thickened of skin	Congestion and edam	Interstitial nephritis
V.	Dadaab	SC-DH-54	Negative	Kidney	reduced of urine	haemorrhages in some arrears	Interstitial nephritis
V.	Dadaab	SC-DH-55	Negative	Kidney	excessive drowsiness	Congested and haemorrhages	Interstitial nephritis
V.	Dadaab	SC-DH-56	Negative	Kidney	Fatigue	Oedematous and congestion	Lymphocytes and macrophages
V.	Dadaab	SC-DH-57	Negative	Heart	Pain, numbness	congestion, and hyperaemia	congestion, and haemorrhages
V.	Dadaab	SC-DH-58	Negative	Heart	Pain and numbness	No gross pathological lesions	Foci of cellular infiltration in the sub-endocardium region
V.	Dadaab	SC-DH-59	Negative	Heart	Not signs	No gross pathological lesions	Losses of nuclei and large,
V.	Dadaab	SC-DH-60	Negative	Lymph node	Swollen	Enlargement and fluids	loss of lymphocytes
V.	Dadaab	SC-DH-61	Negative	Lymph node	Enlarged	Abscess	Eosinophilia in cellular debris
V.	Dadaab	SC-DH-62	Negative	Small intestine	Not signs	No gross lesions	inflammatory infiltrate
V.	Dadaab	SC-DH-63	Negative	Small intestine	Not signs	No gross lesions	inflammatory infiltrate
V.	Dadaab	SC-DH-64	Positive	Small intestine	Not signs	haemorrhages	Congestion oedema and haemorrhages
V.	Dadaab	SC-DH-65	Negative	Lymph node	Abscesses	Swollen and abscess	predominant of inflammatory cells
V.	Dadaab	SC-DH-66	Negative	Lymph node	Swollen	Change in colour and some fluid exists	Macrophages and inflammatory cells

SH. No	Sub-county	Samples	Result	Organs	Clinical signs	Gross lesions	Histopathology
V.	Dadaab	SC-DH-67	Negative	Lymph node	Enlarged	Swelling and abscess	neutrophils and inflammatory cells
V,	Dadaab	SC-DH-68	Negative	Lymph node	Absences	Enlargement of lymph nodes	depletion of paracortical lymphocytes
V.	Dadaab	SC-DH-69	Positive	Liver	Discolorations	haemorrhages and congestion	Hepatocellular spaces
VI.	Dadaab	SC-DH-70	Positive	Liver	White and red spots	No gross pathological lesions	pseudo glandular growth in hepatocytes
VI.	Dadaab	SC-DH-71	Negative	Kidney	Nodular lesion	swelling and congestion of the kidney	Empty spaces and damaged of tubules
VI.	Dadaab	SC-DH-72	Negative	Kidney	persistent nausea	Inflammation and ulcerates	eosinophilia and exudates
VI.	Dadaab	SC-DH-73	Negative	Testicles	Inflammations	Inflammation in different areas of testicles	Seminiferous tubule with Sertoli cells
VI.	Dadaab	SC-DH-74	Negative	Lymph node	Swollen	Swollen and abscess	Congestion and infiltrations
VI.	Dadaab	SC-DH-75	Negative	Testicles	Orchitis	Peritubular fibrosis	Inflammation in testacies
VI.	Dadaab	SC-DH-76	Negative	Testicles	Inflammations	Inflammation	Orchitis
VI.	Dadaab	SC-DH-77	Negative	lymph node	Swollen	Enlargement of lymphocytes	No lesions
VI.	Dadaab	SC-DH-78	Negative	Lymph nodes	Swollen	Enlargement	Infiltrations of immunoblots cells
VI.	Dadaab	SC-DH-79	Negative	Liver	Inflammations	haemorrhages and congestion	Hepatocellular spaces
VI.	Dadaab	SC-DH-80	Negative	Liver	Inflammations	haemorrhages and congestion	Hepatocellular spaces
VI.	Dadaab	SC-DH-81	Negative	Heart	Nausea, indigestion	No gross pathological lesions	Foci of cellular infiltration
VI.	Dadaab	SC-DH-82	Negative	Heart	Indigestion	No gross pathological lesions	Enlargement and internalisation of nuclei
VI.	Dadaab	SC-DH-83	Negative	Kidneys	persistent of nausea	swelling and congestion of the kidney	Empty spaces and damaged of tubules
VI.	Dadaab	SC-DH-84	Negative	Kidneys	Pain and pressure of the chest.	swelling and congestion of the kidney	Empty spaces and damaged of tubules

SH. No	Sub-county	Samples	Result	Organs	Clinical signs	Gross lesions	Histopathology
VI.	Dadaab	SC-DH-85	Negative	Lung	Not clinical signs	Enlarged and congested	Edam in lungs
VI.	Dadaab	SC-DH-86	Negative	Lung	Not clinical signs	Enlarged and congested	Neutrophils in bronchi of lungs
VI..	Dadaab	SC-DH-87	Negative	Liver	Not clinical signs	Haemorrhages in liver	Congestion and haemorrhages
VII.	Dadaab	SC-DH-88	Negative	Liver	Not clinical signs	haemorrhages and congestion	Hepatocellular spaces
VII.	Dadaab	SC-DH-89	Negative	Kidneys	Lethargy.	swelling and congestion of the kidney	Empty spaces and damaged of tubules
VII.	Dadaab	SC-DH-90	Negative	Kidneys	Depression.	swelling and congestion of the kidney	Empty spaces and damaged of tubules
VII.	Dadaab	SC-DH-91	Negative	Kidneys	Increased thirst.	swelling and congestion of the kidney	Empty spaces and damaged of tubules
VII.	Dadaab	SC-DH-92	Negative	Kidneys	Lack of appetite (anorexia)	swelling and congestion of the kidney	Empty spaces and damaged of tubules
VII.	Dadaab	SC-DH-93	Negative	Kidneys	Weight loss.	swelling and congestion of the kidney	Empty spaces and damaged of tubules
VII.	Dadaab	SC-DH-94	Negative	Spleen	Enlarged	Enlarged and congested	Haemorrhages and congestion
VII.	Dadaab	SC-DH-95	Negative	Spleen	in fullness	Enlarged and congested	Haemorrhages and congestion
VII.	Dadaab	SC-DH-96	Negative	Spleen	Swollen	Enlarged and congested	Haemorrhages and congestion
VII.	Dadaab	SC-DH-97	Negative	Liver	Anorexia	Congestion and haemorrhagic	Inflammatory cells and infiltration
VII.	Dadaab	SC-DH-98	Negative	Skin	Wrinkled of the skin	Acanthosis (epidermal hyperplasia)	Thickening of the epidermis.
VII.	Dadaab	SC-DH-99	Negative	Skin	Anaemic of skin	Amyloids in dermis	thickening of the epidermal walls
VII.	Dadaab	SC-DH-100	Negative	Heart	Anorexia	congestion, and hyperaemia	Contraction and necrosis
VIII.	Balambale	SC-BA-101	Negative	Kidneys	Infertility	haemorrhages in some arrears	Interstitial nephritis
VIII.	Balambale	SC-BA-102	Negative	Spleen	Abortion	Enlarged	Congestions
VIII.	Balambale	SC-BA-103	Negative	Testicles	Inflammation	Inflammation	Orchitis
VIII.	Balambale	SC-BA-104	Negative	Testicles	Paine	No gross lesions	No lesions
VIII.	Balambale	SC-BA-105	Negative	Lymph node	Swollen	Fibrins, deposition and discoloration	Lymphoblastic infiltration

SH. No	Sub-county	Samples	Result	Organs	Clinical signs	Gross lesions	Histopathology
VIII.	Balambale	SC-BA-106	Negative	Lymph node	Enlarged	Fibrins, deposition and discoloration	Lymphoblastic infiltration
VIII.	Balambale	SC-BA-107	Negative	Large intestine	Abdominal pain	ulcerative lesions in large intestine	ulcerative colitis in large intestine
VIII..	Balambale	SC-BA-108	Negative	Testicles	Infection	Inflammation	Infections in different areas
VIII.	Balambale	SC-BA-109	Negative	Testicles	Infertility	Congestion and haemorrhages	Oedema haemorrhages
VIII.	Balambale	SC-BA-110	Negative	Kidneys	Epidemies	swelling and congestion of the kidney	Empty spaces and damaged of tubules
VIII.	Balambale	SC-BA-111	Negative	Kidneys	Lameness	haemorrhages and congestion	haemorrhages and oedematous
VIII.	Balambale	SC-BA-112	Negative	Heart	In appetence	haemorrhages and congestion	haemorrhages and congestions
VIII.	Balambale	SC-BA-113	Negative	Lymph nodes	Swollen	Swollen and fluids in some areas	Infiltrations of lymphocytes
VIII.	Balambale	SC-BA-114	Negative	Lymph node	Enlarged	Swollen and fluids in some areas	Infiltrations of lymphocytes
VIII.	Balambale	SC-BA-115	Negative	Skin	Emaciation	extended of epidermal tissue	Thickening of the epidermis.
VIII.	Balambale	SC-BA-116	Negative	Liver	Decreased milk yield	haemorrhages and congestion	Enlargements of hepatocytes
VIII.	Balambale	SC-BA-117	Negative	Liver	Vomiting and diarrhoea	haemorrhages and congestion	Enlargements of hepatocytes
VIII.	Balambale	SC-BA-118	Negative	Lung	Inflammation	Congestion and haemorrhages	Neutrophils in bronchi and infiltrations
VIII.	Balambale	SC-BA-119	Negative	Lung	Blue colour around the lips	Congestion and haemorrhages	Atelectasis (collapse of alveoli)
IX.	Balambale	SC-BA-120	Positive	Lung	Discoloration	Congestion and haemorrhages	Atelectasis (collapse of alveoli)
IX.	Balambale	SC-BA-121	Negative	Lung	Change in lips	Congestion and haemorrhages	Atelectasis (collapse of alveoli)

SH. No	Sub-county	Samples	Result	Organs	Clinical signs	Gross lesions	Histopathology
IX.	Balambale	SC-BA-122	Negative	Liver	febrile illness	No gross pathological lesions	Enlargement of hepatocytes
IX.	Balambale	SC-BA-123	Negative	Kidneys	fever, chills	swelling and congestion of the kidney	Empty spaces and damaged of tubules
IX.	Balambale	SC-BA-124	Negative	Lymph node	Lymphadenopathy	Swollen and some fluids	Immunoblastic infiltrations
IX.	Balambale	SC-BA-125	Negative	Lymph node	Swollen	Abscess and swollen	Immunoblastic infiltrations
IX.	Balambale	SC-BA-126	Negative	Lymph node	Absences	Swollen and abscess	Congestion and infiltrations
IX.	Balambale	SC-BA-127	Negative	Lymph node	Enlarged	Abscess and swollen	Immunoblastic infiltrations
IX.	Balambale	SC-BA-128	Negative	Lymph node	Swollen	Swollen and abscess	Congestion and infiltrations
IX.	Balambale	SC-BA-129	Negative	Lymph node	Enraged	Swollen and abscess	Congestion and infiltrations
X.	Balambale	SC-BA-130	Negative	Liver	Hepatomegaly	Enlargement of liver in some areas	Granulation of tissue can be seen
X.	Balambale	SC-BA-131	Negative	Liver	Hepatomegaly	Vascular degenerative changes	Congestion and necrosis
X.	Balambale	SC-BA-132	Positive	Liver	Hepatomegaly	Vascular degenerative changes	Congestion and necrosis
X.	Balambale	SC-BA-133	Negative	Lung	Hyper inflated of lungs	Enlarged and congested	Interstitial mononuclear infiltrations
X.	Balambale	SC-BA-134	Negative	Lung	Swollen	Enlargement and haemorrhages	Oedema (pinkish materials in alveoli)
X.	Balambale	SC-BA-135	Negative	Kidneys	Lameness	swelling and congestion of the kidney	Empty spaces and damaged of tubules
X.	Balambale	SC-BA-136	Negative	Kidneys	Infection	swelling and congestion of the kidney	Empty spaces and damaged of tubules
X.	Balambale	SC-BA-137	Negative	Heart	Rapid of breathing	haemorrhages and congestions	haemorrhages and spaces in arteries
X.	Balambale	SC-BA-138	Negative	Heart	Lacrimation	haemorrhages and congestions	haemorrhages and spaces in b/w veins
XI.	Balambale	SC-BA-140	Negative	Lymph node	Swollen	Fibrins, deposition and discoloration	Lymphoblastic infiltration

SH. No	Sub-county	Samples	Result	Organs	Clinical signs	Gross lesions	Histopathology
XI.	Balambale	SC-BA-141	Negative	Lymph node	Enlarged	Swollen and abscess	Lymphoblastic infiltration
XI.	Balambale	SC-BA-142	Negative	Lymph node	Absences	Enlargements of lymphocytes	Lymphoblastic infiltration and mononucleosis
XI.	Balambale	SC-BA-143	Positive	Lymph node	Swollen	Abscess and fluids	Infiltration and some areas of dark colours
XI.	Balambale	SC-BA-144	Positive	Lymph node	Abscesses	Enlargement	Infiltrations of immunoblots cells
XI.	Balambale	SC-BA-145	Negative	Lymph node	Enlarged	Enlargement	Infiltrations of immunoblasts cells
XII.	Balambale	SC-BA-146	Negative	Lymph node	Enlarged	Change in colour	Lymphocytic infiltrations
XII.	Balambale	SC-BA-147	Negative	Lymph node	Swollen	Change in colour	Lymphocytic infiltrations
XII.	Balambale	SC-BA-148	Negative	Lymph node	Enlargement	Swollen and fluids in some areas	Infiltrations of lymphocytes
XII.	Balambale	SC-BA-149	Negative	Lymph node	Abscesses	Swollen and fluids in some areas	Infiltrations of lymphocytes
XII.	Balambale	SC-BA-150	Positive	Lymph node	Enlarged	Swollen and fluids in some areas	Infiltrations of lymphocytes
XII.	Balambale	SC-BA-151	Negative	Lymph node	Swollen	Swollen and abscess	predominant of inflammatory cells
XIII.	Balambale	SC-BA-152	Negative	Liver	Anorexia	haemorrhages and congestion	Hepatocellular spaces
XIII.	Balambale	SC-BA-153	Negative	Liver	Runny of noses	haemorrhages and congestion	Hepatocellular spaces
XIII.	Balambale	SC-BA-154	Negative	small intestine	Diarrhoea	haemorrhages	Congestion oedema and haemorrhages
XIII.	Balambale	SC-BA-155	Positive	Intestines	Diarrhoea	Congested area	Congestion oedema and haemorrhages
XIII.	Balambale	SC-BA-156	Negative	Spleen	Enlargement	Swollen area	Congestion and oedema
XIII.	Balambale	SC-BA-157	Negative	Spleen	Splenomegaly	Enlargement	haemorrhages

SH. No	Sub-county	Samples	Result	Organs	Clinical signs	Gross lesions	Histopathology
XIII.	Balambale	SC-BA-158	Positive	Spleen	Splenomegaly	Enlargement	Congestion and some empty spaces
XIII.	Balambale	SC-BA-159	Negative	Heart	Lack of appetences	No gross pathological lesions	There is eosinophilia changes
XIII.	Balambale	SC-BA-160	Negative	Lymph node	Swollen	Abscess and some are is fluid	Infiltration of immunoblasts and occupied empty spaces

GT: Garissa-township

DH: Dadaab

BA: Balambale

SC: sample camel

+Ve: Positive

RBPT: Rose Bangle Plate Test

SAT: Serum Agglutination Test

c-ELISA: Competitive Enzyme Linked Immuno Sorbent Assay

DAG: T Double Ager Gel Test

-Ve: Negatives

Appendix 7.11: Statistical outputs analysis for comparing distribution of DGD test with other tests:

Distribution across the four test:

	RBPT	SAT	c-ELISA	AGID
+Ve	9.43%	10.06%	9.43%	6.29%
-Ve	90.57%	89.94%	90.57%	93.71%

H_0: Observed distribution equal to Expected distribution

H_1: Observed distribution not equal Expected distribution

NB: if the p-value<0.05 then there is a significant difference else no significance difference

. CSG of RBPT, expperc (6.29 93.71)

RBPT	AGID	Expected frequency	Observation frequency
+Ve	6.29	10.0011	15
-Ve	93.71	148.9989	144

Chi-squire: is 2.67, p = .1025

There is no significant difference between the RBPT test and the AGID test

SAT	AGID	Expected frequency	Observation frequency
+Ve	6.29	10.0011	16
-Ve	93.71	148.9989	143

Chi-squire: is 3.84, p = .05
There is no significant difference between the SAT test and the AGID test.

. CSG of c-ELISA, expperc (6.29 93.71)

AGID	Expperc	Expected frequency	Observation frequency
+Ve	6.29	10.0011	10
-Ve	93.71	148.9989	149

Chi-squire: is 2.67, p = .1025

Conclusion: There are no significance difference across all the four tests.