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LESION CHARACTERIZATION, ASSOCIATED RISK FACTORS AND FINANCIAL IMPACT OF HYDATID CYST OF DROMEDARY CAMELS SLAUGHTERED AT ADDIS ABABA AKAKI KALITY MUNICIPAL ABATTOIR, ETHIOPIA

MSc THESIS

BY

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DEPARTMENT OF VETERINARY PATHOLOGY AND PARASITOLOGY

NOVEMBER, 2022

BISHOFTU, ETHIOPIA

LESION CHARACTERIZATION, ASSOCIATED RISK FACTORS AND FINANCIAL IMPACT OF HYDATID CYST OF DROMEDARY CAMELS SLAUGHTERED AT ADDIS ABABA AKAKI KALITY MUNICIPAL ABATTOIR, ETHIOPIA

A Thesis Submitted to College of Veterinary Medicine and Agriculture of Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Master of Veterinary Science in Veterinary Pathology

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As MSc studies consultant, I hereby certify that I actually have advised and evaluated this thesis organized below my steerage through Elias Gezaw, entitled: **"*Lesion Characterization, Associated Risk Factors and Financial Impact of Hydatid Cyst of Dromedary Camels Slaughtered at Addis Ababa Akaki Kality Municipal Abattoir, Ethiopia*"**; I advocate that it could be universal as pleasurable the thesis requirement for the Degree of Master of Veterinary Science in Veterinary Pathology.

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As contributors of the Examining Board of the final MSc open defense, we certify that we have examine and evaluated the thesis organized by Elias Gezaw Anbu, entitled: **"*Lesion Characterization, Associated Risk Factors and Financial impact of Hydatid Cyst of Dromedary Camels Slaughtered at Addis Ababa Akaki Kality Municipal Abattoir, Ethiopia*"** and recommend that it be accepted as fulfilling the thesis requirement for the degree of Masters of Veterinary Science in Veterinary Pathology.

DEDICATION

I dedicate this thesis to the everlasting dwelling Almighty God my creator, my supply of all matters, the father of my admiration, my sturdy pillar, the supply of my knowledge, wisdom, understanding, power and enabler with inside the day of my hassle during this work and I can most effectively use His wings to experience everything. I additionally devoted this work to my consultant Dr. Jirataw Shiferaw who supported me throughout my thesis work. I moreover devoted this thesis to the Animal Health institute who certified me to work in the pathology laboratory, and dearest Solomon and Tewodros who stood through me once I labored with inside the laboratory and advised, recommended and helped me. I further devote this thesis to my dearest wife; Tigist Fituma Refu who has advocated me all of the manner, leads me via the valley of darkness with mild of wish and support, and whose encouragement has made positive that I provide all of it takes to complete that which I even have started. To my kids Birra (Sagni) who has been affected in each manner viable with the aid of using this work. I additionally dedicate this thesis to superb parents, who in no way prevent giving of themselves in innumerable ways; in particular my dearest mom Alemitu Kitila Ejeta and my pricey brother Alemayehu Gezaw, who stands through me while matters of appearance are unwelcoming. Entirely the people in my lifestyle who contact my heart, I dedicate this study. Thank you. My love for you all can in no way be enumerated. May the Lord God bless you in all of your lives.

STATEMENT OF AUTHOR

First, I announce that this thesis is my work and that all sources of material used for this thesis were duly acknowledged. This thesis has been submitted in partial fulfillment of the necessities for a postgraduate (MSc) degree at Addis Ababa University, College of Veterinary Medicine and Agriculture and deposited on the University/College library to be made debtors under policies of the library. I critically claim that this thesis isn't always submitted to every other organization for the award of any educational degree, diploma, or certificate.

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LIST OF ABBREVIATIONS

AHI	Animal Health Institute
CSA	Central Statistical Authority
EITB	Enzyme-linked ImmunoelectroTransfer Blot
ELISA	Enzyme-linked Immunosorbent Assay
ETB	Ethiopian Birr
FAO	Food and Agriculture Organizations
IGAD	Intergovernmental Authority on Development
MRI	Magnetic Resonance Imaging
NMA	National Meteorological Agency
NMSAE	National Meteorology Service Agency of Ethiopia
OIE	World Organization for Animal Health, formerly the Office International des Epizooties
OR	Odds ratio
SNNP	South Nations and Nationalities Peoples' Region
WHO	World Health Organization

ABSTRACT

A cross-sectional study was conducted from October 2021 to May 2022 to characterize hydatid cyst lesions, analyze associated risk factors and estimate the annual direct financial loss due to hydatid cyst infected organs condemnation during postmortem examination in dromedary camels slaughtered at Addis Ababa Akaki Kality Municipal abattoir, Ethiopia. A total of 370 camels were purposively sampled and systemic meat inspection was employed to detect the presence of hydatid cyst. Out of 370 examined dromedary camels in different organs, 96 (25.9%) camels were found harboring hydatid cyst. The percentage of hydatid cyst in adult camels were 29.67%; OR= 1.54 while in young it was 18.55%. Likewise, the prevalence of hydatid cyst in poor, medium and good body condition score was 61.4%; OR= 10.79, 30.89%; OR= 3.30 and 12.11% respectively. The current results indicated that age and body condition score were significantly ($P<0.05$) associated with the prevalence of hydatid cyst. The prevalence of hydatid cyst in male dromedary camel was (14.59%) found higher than female (11.35%). The prevalence of hydatid cyst in camels originated from Borana, East Hararge, Jigjiga, Karrayyu, Matahara, Minjar-shenkora and Wollo were 9.18%, 0.54%, 4.86%, 3.51%, 3.78%, 1.08% and 2.97%, respectively. The result indicated, origin and sex didn't have significant association ($P>0.05$) with the prevalence of hydatid cyst. Out of 96 totally infected camels, only 9 (9.38%) cases had hydatid cyst on both lung and liver while the remaining 87 (90.62%) cases had hydatid cysts only in single organ. Of 105 totally infected organs, percentage of distribution of hydatid cyst in lungs, livers, spleen and heart were 87.61%, 10.47%, 0.95% and 0.95% respectively. Grossly, hydatid cyst of lung had a shape of cotton ball, implanted in lung parenchyma, filled with clear to slightly turbid fluid, soft and malleable to touch and inside white germinal layer while hydatid cyst of the livers was firm, calcified and strong when it was about to be cut off. Microscopically, hydatid cyst structure overlying organs had a fibrous layer on the external (pericyst), an acellular eosinophilic laminated membrane layer on the middle (ectocyst) and a germinal layer internally (endocyst) and protoscolices were also seen in a lung section. Fibrous layer had infiltration of epitheliod macrophages, lymphocytes and eosinophils showed inflammatory response to hydatid cyst layer and cellular infiltration was lessened when they went away from hydatid cysts. Histopathology of lungs infected with hydatid cyst displayed massive alveolar damage, some alveoli were emphysematous, congested, hemorrhagic and atelectatic in the fibrous layer. In

hydatid cyst infected liver histology, there was hemorrhage, hepatocyte degeneration and cytoplasmic swelling with dilation of nucleus in fibrous layer. The total annual direct financial loss due to hydatid cyst was estimated to be 86,209.63 Ethiopian birr. As conclusion, this study helps to identify pathological patterns, prevalence and financial impact of hydatid cysts at Addis Ababa Akaki Kality Municipal abattoir. So that creation of public awareness and control of stray dogs were suggested recommendation.

Key words: Abattoir, Camels, Financial impact, Histopathology, Hydatid cyst, Prevalence.

1. INTRODUCTION

In the world there are about 30 million dromedary camels, but most are in the Africa and Middle East (FAO, 2016). The dromedary camels are used for various purposes; which able to produce milk, meat, wool and hides in dry-land regions of pastoralist in East Africa (Somalia, Sudan, Ethiopia, Kenya, Djibouti and Eritrea) and the pastoral area of East Africa is home to about 14.5 million dromedary camels (FAO, 2009).

In Ethiopia, there were about 1.23 million camels (CSA, 2016). The unique behavior of dromedary camels other than animals is their resilience with inside the arid environments, giving an essential source of meal and profits for human beings in dry climates (Watson *et al*., 2016). However, pastorals' production remains low due to lack of improved genetics, feed shortages, disease, poor animal health care and low technology (Tefera, 2012).

Camel meat is a good and preferred food for pastoralist and Somali ethnic groups in the Addis Ababa, capital city of Ethiopia (Muskin *et al*., 2011), especially for those living in the Bole area. However, parasitic diseases of camels cause various economic problems in terms of minimizing the work, reducing the growth and production of meat and milk and condemnation of edible organs (Dakkak, 2010). Also, a few camel's parasites cause troubles with human fitness (Romazanvoc, 2001; Sazmand and Joachim, 2017).

Hydatid cyst is a zoonotic parasitic illness because of *Echinococcus (E.) granulosus* affecting livestock and human beings (Singh *et al*., 2010). It has an indirect life cycle using dogs, jackals and foxes as definitive hosts and produces eggs which handed into the feces and because of ingestion of the eggs, infection passes to the natural herbal intermediate host, generally herbivores such as camels, sheep, goats, cattle, cervids, swine, and horses whilst grazing. Adult *E. granulosus* tapeworm survives in the small intestines of definitive hosts, namely canids specifically in dogs (Ahmadi and Meshkehkar, 2011). Besides, people are infected when eggs or larvae from definitive hosts are launched into the surrounding with feces, and people by accident devour infected green foods or water (Jenkinsa *et al*., 2005; Santivanez and Garcia, 2010). When the egg is eaten up by way of means of an intermediate host, it releases embryos (oncospheres);

embryos tour through the small intestinal wall until it reaches the small vessels of the intermediate host and migrate to the organs which include liver, lung, kidney, heart and spleen through blood circulation and or lymphatics and expand in to a hydatid cyst. Most of them are caught in the hepatic sinusoids. Embryos with much less than 0.03 mm may pass through the hepatic sinusoids and relax in the lungs (Sarkar *et al.*, 2016). The life cycle of the *E. granulosus* is finished whilst the definitive host ingested hydatid cyst infected organs of intermediate hosts.

In livestock hydatid cyst doesn't show main clinical signs and it is noticed only at a time of postmortem examination and causes economic losses by the way of condemnation of infected organs (liver, lung, heart, spleen and kidney) and lowered meat and milk production (Torgerson, 2003). Hydatid cyst frequently grows silently over many years and clinical signs are immediately associated with the predilection site, size and burden of cysts exist (Zhang *et al*., 2014).

There are no sufficient tests to diagnose hydatid cysts in animals as in human beings (Njoroge *et al*., 2002). The analysis of intrathoracic hydatid cyst is primarily based totally at the imaging characteristics and serologic tests. Infrequently, infection and degeneration of the cyst may hamper the accurate diagnosis and, in those cases, histology confirms the proper diagnosis and prognosis (Alloubi, 2013). Microscopic tissue examination confirms the cyst diagnosis after 10% buffered formalin fixed tissue is processed with the aid of different staining methods. Microscopically, growth and the development of hydatid cyst structure belong to host tissue and hydatid cysts. Hydatid cyst has an outside cuticular membrane and an internal proligerous membrane produced by budding proligerous vesicles, the cyst is full of a clean to turbid liquid. The adventitious is fibrous area corresponding to host reaction to the cyst (Carmen *et al*., 2010).

The preventive and control programs need disturbing the life cycle of the *E. granulosus* acting on the epidemiological chain (Guisantes, 2014). Health education, hygiene perfection, meat examination and abattoirs facilities, and rising safe water supplies (horizontal approach) and testing dogs to check for *E. granulosus*, systematic dosing of dogs with praziquantel and immense lessening of dog numbers, including baseline investigating survey and continuing surveillance of livestock and human infections (vertical approach) were two main control programs employed (Gemmell, 2001).

Abundant researches were carried out in our country, Ethiopia on cattle, sheep and goat hydatid cysts (Abriham, 2021). Irrespective of the wonderful environmental and financial fee of the dromedary camels to the livelihood of the pastoral society who do now no longer have any opportunity means of production system, there are rare research reported on hydatid cyst of camels (Abdiselam *et al*. (2014); Aboma *et al*. (2015); Bayleyegn *et al*. (2013); Boru *et al*. (2013); Dawit *et al*. (2019); Etana *et al*. (2015); Mekuanent *et al*. (2015); Abebe *et al*. (2021), and Zeleke and Berkeley (2000)) as compared with that of different home animals in Ethiopia. Yet, camels are intermediate hosts for hydatid cysts like different livestock (Omer *et al*., 2004). In this regard, abnormalities of carcasses suitable for eating organs put the community at risk of acquiring zoonotic food borne illnesses. Also, organ condemnation marks critical financial loss in the country, Ethiopia (Dawit *et al*., 2019). Also, the increase in the number of camels slaughtered and the extensive area coverage of the source of dromedary camels slaughtered at the abattoir requires an up-to-date figures and information (Dawit *et al*., 2019). So that histopathology of hydatid cyst confirms the correct diagnosis (Alloubi, 2013). Therefore, abattoir-based research is needed to estimate associated risk factors on occurrence of hydatid cysts, lesions characterization in organs of camels and this will expect its financial loss and public health significance.

Therefore, the objectives of current study are:

1) To estimate the prevalence of hydatid cyst in dromedary camels slaughtered at Addis Ababa Akaki Kality Municipal abattoir, Ethiopia.
2) To assess the associated risk factors with the occurrence of hydatid cyst.
3) To characterize hydatid cyst lesions in dromedary camels slaughtered at Addis Ababa Akaki Kality Municipal abattoir, Ethiopia.
4) To calculate direct annual financial loss because of organ condemnation in dromedary camels slaughtered at Addis Ababa Akaki Kality Municipal abattoir, Ethiopia.

2. LITERATURE REVIEW

2.1. Distribution and Importance of Dromedary Camels

The World population of domesticated large camelids (Bactrian and Dromedaries) is estimated to be around 28 million. This number is possibly underestimated. Particularly, in the Sahelian countries (Mauritania, Mali, Niger, Chad, Sudan, Ethiopia). Greater than 80% of the camel population resides Africa with 60% in the Eastern African countries (Ethiopia, Kenya, Somalia and Sudan) which are significant exporters of dromedary camels to the Arabian Peninsula and Egypt (Faye, 2015).

The camel population in Ethiopia is estimated at about 4.8 million (Behnke 2010). Most camel possessing community in Ethiopia include Afar, Kunama, Irob, Oromo (Karayu, Gabra, Boran and Guji groups) and Somali peoples. The Afar and the Somali societies are known for their camel-keeping traditions for centuries; the Boran and Guji pastoralists, on the other hand, started camel production recently. Gabra and Somali, who have been caring camels for centuries, are believed to play instrumental roles in familiarizing camels to the Borana Plateau (Coppock 1994). The Borana people are converting from cattle to camel production, as the area is changing from grassland to bush encroachment due to climate change.

In Ethiopia, around half of a country has arid and semi-arid climatic conditions (Coppock, 1993) and this area is thought to be home to 6-10% of the Ethiopian population (Ayele, 1989). Dromedary camels, have exceptional anatomical, behavioral features and physiological natures, are well adapted and known to provide basic necessities to pastoralists who live in arid and semi-arid regions. It is a source of food and power, respect and cash, and means of storing wealth (Zeleke and Bekele, 2000). The camel race is still very popular in gulf countries especially. This activity pushed many innovative research on genetic, biotechnology, physiology and contribute to a better understanding of the camel biology (Faye, 2015).

The most common sources of protein come from animals. Parasites, however, undermine their profit by impeding the health and production. Mortality of animals from parasitic diseases won't

be horrifying at the moment however they lessen milk, meat, wool, skin and hide manufacture, infertility and bring about lack of power of working animals (Derbala and Zayed, 1997).

2.2. Etiology of Hydatid Cyst

Hydatid cyst is a zoonotic disease caused by Echinococcus spp. (*E. granulosus* and *E. multilocularis*) and transmitted when a person eats an embryonated egg materials like green food and drinks egg contaminated water (Muller, 2002). Other Echinococcus species which can cause hydatid cys are *E. oligarthrus* and *E. vogeli*. Hydatid diseases in humans is generally caused by infection with the larval stage of the dog tapeworm, *E. granulosus* (WHO, 2015). Camels are infected with metacestodes of Echinococcus species (El-Metenawy, 1999).

2.3. Geographic Distribution

Hydatid cyst due to *E. granulosus* frequently predominant in sheep rising parts of the Australia, Mediterranean, South America, New Zealand, South Africa and the Middle East including Saudi Arabia (Toulah *et al*., 2012). It is stated in Africa typically where cattle raised in a free range related closely with dogs (Abebeand Yilma, 2013). Hydatid cyst is major cestodes which are described from camels in India (Parsini *et al*., 2008).

Knowing where the infection found plays an important role in preventing the spread of the disease. Hydatid cyst is widely distributed worldwide on different hosts with varying prevalence (WHO/OIE, 2001). Highest prevalence of hydatid cyst in humans and animals is found in rural and temperate areas, specifically in growing international locations in which there's near contact among canine and intermediate hosts (Eckert and Deplazes, 2004). In many African countries, the lack of proper meat inspection, especially in rural areas and presence of a huge populace of stray canine has caused an excessive prevalence of disorder (Magambo *et al.,* 2006).

Risk factors such as proper climatic and ecological conditions, slaughter of animals at home and the presence of many stray dogs make hydatid cysts survive (Seimenis *et al*., 2006). In areas with a large number of livestock breeders which don't have proper veterinary service assistance and

the offal of slaughtered animals has easy access to a dog, the transmission and prevalence of hydatid cyst is high enough (Eckert *et al*., 2001).

2.4. Life Cycle of Cystic Echinococcosis

Echinococcus species have an indirect life cycle, and necessity to develop in both an intermediate and a definitive host. Adult worms live in the small intestine of the definitive host and they reproduce releasing eggs into the environment in the faeces of the definitive host animal (The Center for Food Security and Public Health, 2012).

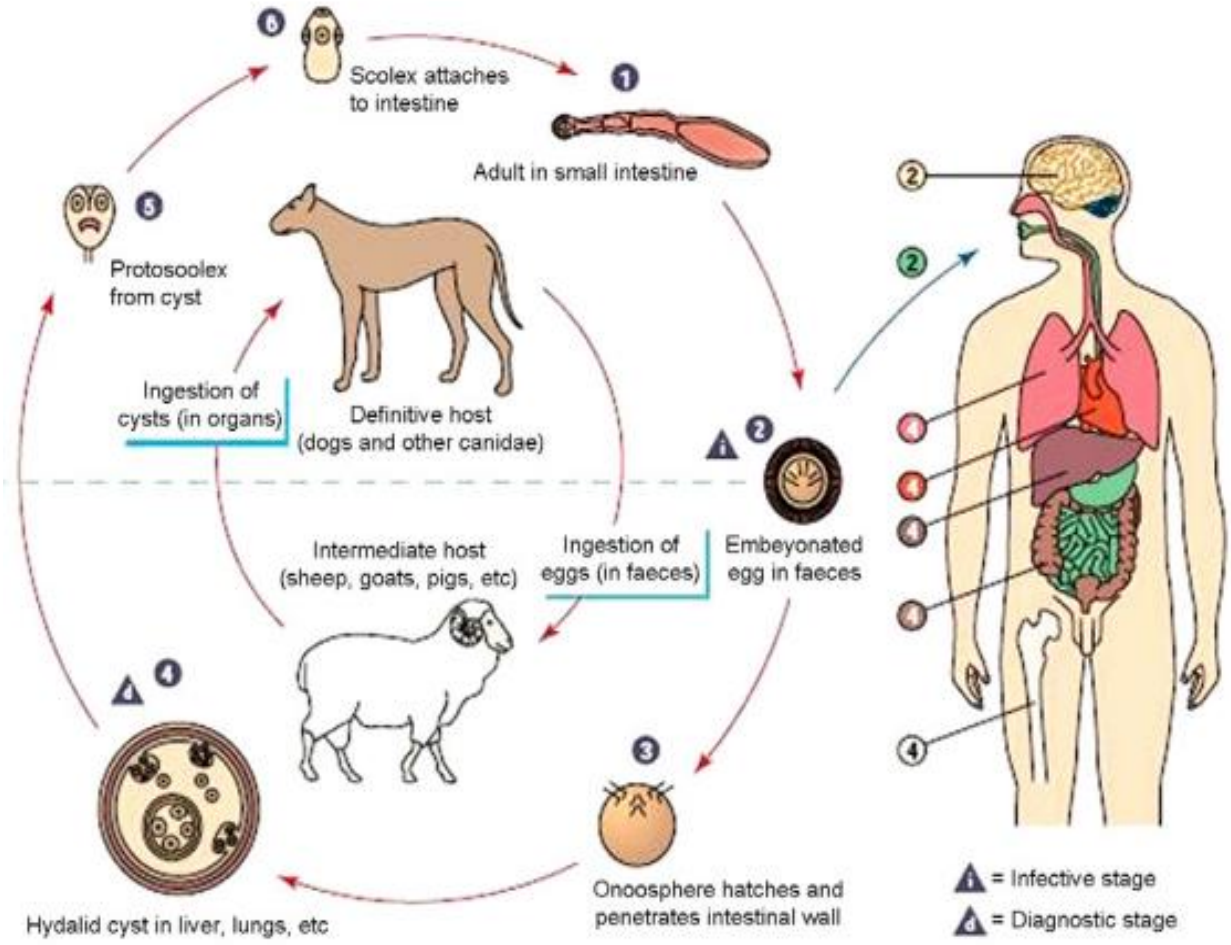


Figure 1- Life cycle of *Echinococcus granulosus.*

Source: The Center for Diseases Control and Prevention, http://www.dpd.cdc.gov/dpdx/html/Echinococcosis.htm.

The adult *E. granulosus* (3-6 mm long) exist in the small intestine of the definitive hosts, dogs or other canids. Gravid proglottids release eggs that are passed in to the feces. After ingestion by a suitable intermediate host (camel, sheep, goat, swine, cattle and horses), the egg hatches in the small intestine and releases an oncosphere that penetrates the intestinal wall and migrates through the circulatory system into various organs, especially the liver and lungs. In these organs, the oncosphere grows into a hydatid cyst that enlarges slowly, producing protoscolices and daughter hydatid cysts that fill the cyst internally. The definitive host becomes infected by ingesting the hydatid cyst containing organs of the infected intermediate host. After ingestion, the protoscolices evaginate, attach to the intestinal mucosa, and develop into adult stages in 32 to 80 days. Image courtesy of the Center for Diseases Control and Prevention, CDC-DPDx.

2.5. Clinical Signs

Animals with hydatid cysts show no clinical signs since the cyst is slow in growing and animals are often slaughtered before it manages to create sufficient pressure on the organs, but little information indicates it has an effect on production of the animal especially decrease in carcass weight, milk production, and fleece value, losses of offal and fertility losses (Yildiz and Gurcan, 2003). The outcome of hydatid cyst on the intermediate host depends on the extent and location of the hydatid cyst. If large cyst is located in an area of the body such as the lungs or brain, the significances can be very serious (Daryani *et al*., 2007). Generalized pruritis and fever are systemic symptoms frequently related with hydatid diseases. Rupture of hydatid cysts, principally into serosal cavities, may cause acute and sometimes fatal anaphylactic reaction (Parry *et al*., 2004). The adult Echinococcus is considered to be harmless to the definitive host, apart from when it occurs in large numbers, which may cause severe enteritis (Dunn, 1987).

2.6. Pathology of hydatid cyst

Hydatid cyst have round cotton ball shaped, fluid-filled, unilocular cyst that consists of an inner germinal layer of cells maintained by a characteristic acidophilic-staining, acellular, laminated membrane of variable thickness containing numerous tiny protoscolices. Hydatid cyst most often mature in the liver and lungs and also develop in the spleen, kidney, nervous tissue, bone and

other organs (Seimenis, 2003). The histopathological structure of common hydatid cyst in the organs, comprising a germinal layer, cuticular membrane or laminated cyst wall, fibrous tissue capsule and cellular infiltration. The fibrous capsule consists of a thick connective tissue layer which has inflammatory infiltrates holding masses of lymphocytes, eosinophils, histiocytes and plasma cells in surrounding tissue (Bektas *et al*., 2016).

Camel lung affected with hydatid cyst wall designed of thick fibrous connective tissue, cyst lumen filled with clear to turbid liquid and the adjacent tissues showed atelectasis, hemorrhage and emphysema. Hydatid cyst overlying the liver is filled with caseated materials which is mixed with dystrophic calcification and surrounded by fibrous capsule and mononuclear inflammatory cells. And camels' liver shows hyperplasia, thickening of bile duct and atrophy of liver cells due to fibrous proliferation (Dyab *et al.,* 2020). Microscopic result of liver show multilocular cysts of finely and amphophilic laminated membrane (ectocyst) and geminal layers (endocyst) surrounded by fibrinous walls (pericyst) (Wei-Hsin *et al*., 2005).

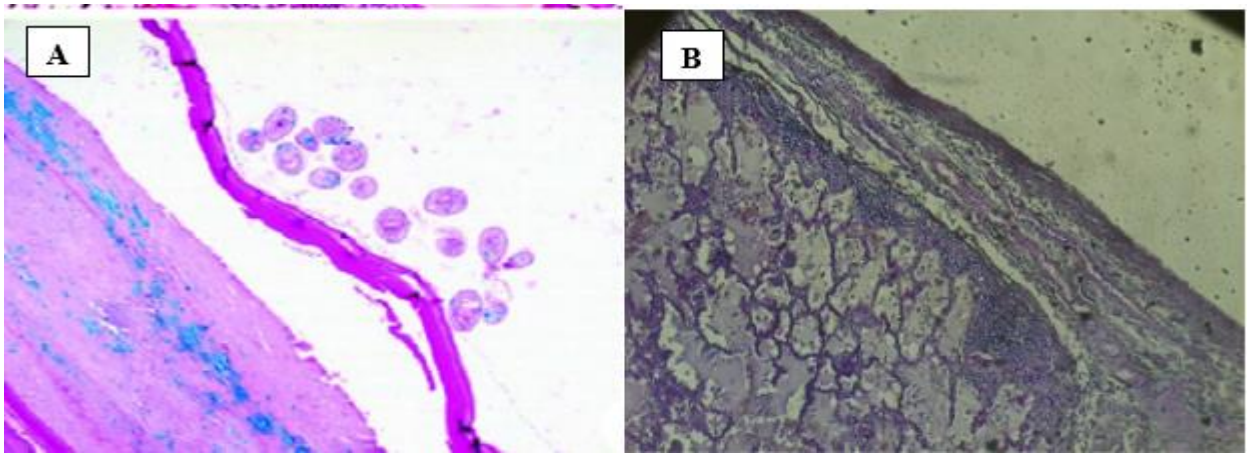


Figure 2- Hydatid cyst structure on lung and liver. A. Lung affected with hydatid cyst exhibiting laminated membranes, germinal layers, and brood capsules positive for neutral mucopolysaccharide and the adventitia positive for acid mucopolysaccharides. Alcian Blue-PASx100 (Beigh et al., 2018). B. The structure of hydatid cyst of the liver: endokyste (membrane proligerous) ectokyste (laminated membrane) and with the formation of perikyste syncytial layer cell type (Gross, X100) (Khadidja et al., 2014).

2.7. Diagnosis of Hydatid Cyst

In Ethiopia as much as date, no dependable laboratory technique has been mounted to diagnose livestock and so, cystic echinococcosis is diagnosed mainly dependent on postmortem examination (Njoroge *et al*., 2002). However, hydatid cysts are diagnosed in laboratory by CT-scan, MRI, X-ray, many serological methods: Enzyme-linked immunosorbent Assay (ELISA) and Fast-ELISA with sensitivity (Haniloo *et al*., 2005 and Rokni *et al.*, 2006), Dot ELISA (Dalimi *et al*., 2000), Enzyme linked Immuno electron Transfer Blot (EITB) (Rokni and Aminian, 2006). At present, ELISA method using AgB is the most efficient test and is accessible in some laboratories (Sadjjadi *et al*., 2007).

However, there is largely unsuccessful serological diagnosis in intermediate hosts when compared with the examination in humans, due to the coexistence of multiple infections with taeniid species, cross reactivity of antigens and low-level antibody response to infections. Now, postmortem examination is the test of high-quality for the diagnosis of hydatid cyst in the intermediate host. Nevertheless, out of postmortem positive intermediate hosts might actually be false positive due to condition like unclear granulomas, pseudotuberculosis, fatty degeneration, abscesses, caseous enlargement of lymph node usually due to infection and larval stage of *Taenia hydatigena* can confuse the positive results. Additionally false negative diagnosis could also be made due to small intra-parenchyma cysts (Zhang *et al*., 2012).

2.8. Treatments

Chemotherapy with benzimidazole compounds and, more of late, treatment with cyst puncture, aspiration, injection of chemicals and re-aspiration have been presented and, gradually, have replaced surgery as the favored treatment for intermediate host (camel, cattle, sheep, goat and pig) (Pawlowski *et al*., 2001). The combination of praziquantel and albendazole has been used successfully in the treatment of hydatid disease. Praziquantel used at 50 mg/kg in different schedules (once daily, once weekly, or once every two weeks) with albendazole formed very effective and quick outcomes associated with albendazole therapy alone. Albendazole (10-15 mg/kg/day) and mebendazole (40-50 mg/kg/day) have established usefulness; though, the outcomes for albendazole have been superior, possibly because of its pharmacokinetic profile,

which favors intestinal absorption and penetration into the cyst (Cobo *et al*., 1998). Another treatment choice of hydatid cysts consists of: (1) percutaneous puncture using sonographic guidance, (2) aspiration of substantial amounts of the liquid contents, (3) injection of a protoscolicidal agent (e.g., 95% ethanol or hypertonic saline) for at least 15 minutes, and (4) re-aspiration (PAIR, puncture, aspiration, injection, and re-aspiration) (Smego *et al*., 2003).

2.9. Prevention and Control

Disruption of the life cycle of *E. granulosus* acting on the definitive hosts (dogs and other canids), the intermediate hosts (camels, cattle, goats and sheep, pigs, horses) and the human population helps to prevent hydatid diseases (Guisantes, 2014). Systematic screening and treatment of diseased dogs was successfully eradicated the disease in endemic area of New Zealand. Inhibiting the feeding of infected raw offal's by proper disposal of hydatid cysts possessing condemned offal's at local slaughterhouses, abattoirs, back yards and on farms. Introduction of suitable meat inspection, creation of local slaughterhouses, effective application of legislative measures, burning or burial of condemned offal's and sterilization of offal's when it is going to be used as dog feed is additional control method of hydatid diseases. (Craig *et al*., 2007).

Health education is another method for the control and prevention of echinococcosis which consists of three activities which rely on each other: 1) Information which comprises the transfer of professional knowledge to the group targeted and highlight certain ideas to get the community to actively participate in preventive activities. 2) Health education sensu strictu that designed to target groups who are not professionally concerned about the problem, such as schoolchildren or the public at large. 3) Occupational training which targets those who must implement health standards in their professional doings (such as farmers and butchers) (Parodi *et al*., 2001).

In human being, the prevention is mostly depending on personal hygiene which comprises avoiding interaction with unknown dogs that may be infected with parasite, washing hands before eating a food, and washing raw vegetables before eating them. Treat the dogs regularly with praziquantel and avoid feeding them with raw offal potentially infected with hydatid cysts.

Examination of dog feces over the study of coproantigens is another measure of care at the household level. All person handling dogs in endemic areas must be aware of the health risk of acquiring hydatid diseases and get safety measures (Guisantes, 2014).

2.10. Economic and public health importance

Hydatid diseases have major economic significance in both animals and humans (Torgerson and Budke, 2003). Hydatid cyst causes considerable economic importance due to reduced productivity and monetary losses because of carcass and organ condemnations at abattoir in different countries of the world (Scala *et al*., 2005). The levels of hydatid cysts impose a huge medical, economic and social burden in the affected areas. The price of the treatment for patients with the hydatid disease (chemotherapy via albendazole and mebendazole or praziquantel, puncture aspiration injection reaspiration (PAIR) and surgery) is also a significant cost to the patient (Ahmadnia *et al*., 2013).

Large economic loss occurs through prohibitions of importation and exportation of animals and their products especially from endemic areas (Sariozkan and Yalcin, 2009). In humans, the economic damage is related with the direct financial loss due to diagnosis, hospitalization and surgical or percutaneous treatments. Medication, post-treatment assistance, travel by the patient and family to treat him and various expenses incurred in the hospital can be cited as economic problem. In addition, if the sick person is not tested, the disable will cause him to stop working. This means, that a country's productivity decreases and also 1%-2% of hydatid diseases cases can be fatal (Torgerson *et al*., 2003).

3. MATERIALS AND METHODS

3.1. Study Area Description

The study was conducted at Addis Ababa Akaki Kality Municipal abattoir from October 2021-May 2022, which is located in Addis Ababa; (Capital city of Ethiopia) with mean annual minimum and maximum temperature of about 21-27^{o}C, respectively. Addis Ababa is positioned at 9°1'48' North 38° 44°-24' East/ 9.03000^{0}N 38.74000^{0}E, at a mean altitude of 2500 m above sea stage. The annual rainfall is about 800 to 1100 mm (NMSAE, 2012). Even if the camel meat is not commonly known in Addis Ababa city, Somali community, some people come from abroad and a smaller number of Muslim communities who live in the city are the main consumers of camel meat from Akaki Kality slaughterhouse (Boru *et al*., 2013). As a result, the Akaki Kality abattoir usually slaughters an average of seven camels per day. But there is also another slaughtered animal daily (cattle, sheep and goats) in Akaki Kality Municipal abattoir and then gives service to the hotels and restaurants of the Akaki town district. Camels slaughtered at Akaki Kality Municipal abattoir were from Borana, East Hararge, Jigjiga, Karrayyu, Minjar-Shenkora district and Wollo.

Borana zone is found in Oromia regional state, southern part of Ethiopia and has 962,489 total populations of peoples (CSA, 2007). It is bordered by Kenya in the South, West Guji zone in the North, Somali region and Guji zone in the East and South Nations and Nationalities Peoples' Region (SNNPR) in the West. Astronomically, this area stretches from 3°30' N to 5°25' N latitude and 36°40' E to 39°45' E longitude. Yabelo is the capital town of Borana zone and located at about 570 km South of Addis Ababa. It is almost 48,360 km^{2} out of which more than 75% is lowland. It has a mean monthly precipitation of 39.19mm and a monthly mean maximum temperature and minimum temperature of 29.66^{0}C and 16.31^{0}C respectively (Worku *et al*., 2022). The comfortably high temperature length withinside the 12 month is from March to May, even as the bottom yearly minimum temperatures get up among November and January (NMA, 2007). The average annual rainfall ranges from 350 mm to about 900 mm which is distributed through the two rainy time of year from March to May and September to October (Debela *et al*. 2019).

East Hararge area is sited withinside the eastern Ethiopia and bounded through Bale quarter to the south and southwest, Dire Dawa administration council to the north; Somali regional state to the north, east and south east and west Hararghe sector to the west. Totally, Harari area is surrounded with the aid of using east Hararge neighborhood. To the east, Harar is 510 km from Addis Ababa, Ethiopia. The altitude ranges from 500-3,400 meters above sea levels. The area takes three agro-ecological zones; baddaa (upland raises above 2,300m, rainfall 1,200mm-2,000mm), bad-daree (midlands-elevation among 1,500m and 2,300m, rainwater 600mm^3-2,000mm^3 and gammoojjii (lowland- under 1,500m). Total area of the east Hararge is 24,247.7km^2 (Degefa and Tesfaye, 2008). East Hararghe quarter hold 216,943 overall populations of humans (Central Statistical Authority/CSA, 2007).

Jigjiga (capital city of Ethiopian Somali Regional State) located at 9^o 20' north latitude and 42^o 47' east longitude and has a distance of 628km to the east of Addis Ababa. The elevation of the region levels from 900-1600 meters above sea level and gets a yearly rainfall of 300-500mm with the mean minimal and most annual temperatures of 20^o C and 28°C, respectively. The peoples of this region are pastoralist and agro-pastoralist and, whose livelihood is based on high milk they get from camels, cows and goats (Somali Regional State, Ethiopia, 2004).

The Karrayyuu is indigenous peoples of Fantalle district and they are the clans of Oromo (Gebre, 2009). Karrayyuu have fundamental clans particularly Baso (stay in Eastern of a district) and Dullacha (live in western part). Karrayyu located two hundred kilometers East from Addis Ababa, Ethiopia (Debela, 2014). Estimated total populations of Fantalle district (Karrayyu) is 70,049 (CSA, 2006). Fantalle has 18 agropastoral affiliation and two urban centers namely Matahara and Haroo Adii which are approximately 5 km apart. Yearly rainfall is set about 500mm and anticipated to get 10^{0}C and 42^{0}C minimal and most temperature, respectively (Beyene and Gudina, 2009).

Minjar-Shenkora district in the northern shoa zone is an Amhara regional state which is located at 129km east of Addis Ababa. Approximately the district has an entire area of 229,463 hectares and a complete populace of 152,430. It raises varieties from 1,040 to 2,380 meters directly above sea level. Flat landscape (84%) with a small number of ragged mountains is the principal

topography of a district. The average temperature varies from 14 ºC to 27 ºC whereas the annual rainfall changes between 780mm and 900 mm. The important farming scheme in this area is blended crop and small and large ruminant production (Setotaw *et al*., 2014).

South Wollo is located in the northern components of Ethiopia (CSA, 2008). The area is known by different mountain, hilly, plateaus and sloppy areas, streams, rivers and lakes. The altitude tiers from 1500-2600 meters above sea level. The middling rate of rainfall ranges from 39.63mm to 1000 millimeters. This area has minimum and maximum temperature of 11.6 ^{0}C and 23.9 ^{0}C, respectively. The relative humidity of the place varies from 23% to 79% (Hailu *et al*., 2013). North Wollo management sector is positioned north of Addis Ababa and eastern of Amhara regional state within $8^0$95'- $12^0$8'N longitude and $38^0$5'-$40^0$20'E latitude. The altitude varies from 700-4100 meters above sea levels. The annual rainfall varies from 650 to 1200mm, and the minimum and most temperature is 16 ^{0}C and 25 ^{0}C, respectively (Belay, 2010). This administrative zone has 1,731,849 human populations with an expected area of 16,400.98 km^2 (CSA, 2003).

3.2. Study Animal

All camels (*Camelus dromedarius*) which came for slaughter at Addis Ababa, Akaki Kality Municipal abattoir included in the study population. Both gender of camels (male and female) was subjected during the study period and age of the camels were grouped mainly based on teeth (deciduous dental formulation in camel; 2(I 1/3, C 1/1, P 3/3 and M 0/0=24) and permanent dental formulation; 2(I 1 / 3, C 1 / l, P 3 / 2 and M 3 / 3) =34 (Kertesz, 1993). And the age became classified as young when they were in deciduous dental formula (much less than five years) and adult once they were grouped in permanent dental formula (≥ five years of age) in accordance with standard specified by Bello *et al*. (2013). The body condition grading classified as poor, medium and good based on the rule of thumb given through Faye *et al.* (2001) for dromedary camels. This turned into via way of means of observing on the back (ischial tuberosity, sacrotuberous ligament, anogenital region, spinous apophysis) and flank (coxal tuberosity, hole of the flank, transverse apophyses, ribs and their humps).

3.3. Study design

A cross-sectional study executed from October 2021 to May 2022 in Addis Ababa, Akaki Kality Municipal abattoir. Data of lesion related to hydatid cyst on camels were gathered to signify the zoonotic hydatid cyst of dromedary camels, associated risk factors and direct yearly financial loss because of condemned carcass and organs like liver, lung, kidney, heart, spleen and brain.

3.4. Sampling method and sample size determination

During the day of sample collection at abattoir, all camels were purposively taken for examination until the end of the required sample size reached. On the day of investigation, all camels presented for slaughter (per day average of seven camels which was too small) were sampled and a total of 370 camels were examined based on the formula given by Thrusfield and Christley, (2018) and with expected prevalence of 38.22% (Abebe *et al*., 2021). Using 5% degree of absolute precision, 363 camels were needed to be taken for study. However, additional 7 camels were involved as in attendance of inspection had been enough to consist of further samples which increases the precision of the study, and overall, of 370 dromedary camels were examined for the presence of hydatid cysts in different organs like liver, lungs, kidneys, heart, brain, gastrointestinal tract and spleen for better conclusion.

$N= \quad Z^2pq/ d^2$

Where N=number of camels to be sampled; P=expected prevalence, d=desired absolute precision, d =0.05; the value of Z at 95% confidence interval.

3.5. Study Methodology

Both ante-mortem and post-mortem meat inspection strategies were performed at Akaki Kality Municipal abattoir (n= 370).

3.5.1. Ante-Mortem Examination

Ante-mortem examination was conducted on individual and cluster of dromedary camels once they entered into the lairage. Right and left aspects of the camels inspected at rest and in motion. Additionally, the overall conduct of the camels, cleanness, and signal of illnesses and abnormality became documented in line with the usual ante-mortem inspection methods (FAO, 1994). Origins, sex, body conditions score and age of the camels has been recorded earlier than slaughter of camels. The body condition rating of the camels has been assessed in step with Faye *et al*. (2001) after which it is grouped as poor (score zero and one), medium (score two and three) and good (score four and five). The age of the camels anticipated the use of rostral dentition Bello *et al*. (2013) and after which they were classified as young (much less than five years) and adult (greater than five years of age).

3.5.2. Post-Mortem Examination and Gross Pathology

Postmortem examination was carried out through visible inspection, palpation and systemic incision of every visceral organ particularly the lung, liver, heart, kidney and spleen according to Getaw *et al*. (2010). One or more incisions of every organ were made with the knife after the blood has been cleansed from it with water. Whenever cysts had been present, they have been removed, the gross pathology lesions were described (magnitude, size and consistency) and the representative of the alternative tissue become taken and placed into prefilled universal bottles with 10% buffered formalin, labeled and then taken to Animal health institute pathology laboratory at Sabeta for further studies.

3.5.3. Number of hydatid cyst on organs

All organs which had hydatid cysts on their surface and of their parenchyma have been gathered and the entire number of hydatid cysts in every affected organ turned in to count to compute the load of burden on the organ. After counting the cyst quantity on every organ, it was then labeled as less than three cysts and more than or equal to three cysts (Abraham *et al*., 2019). This class

becomes primarily based on frequency of cyst quantity on examined organs at some point of the look at duration of study.

3.5.4. Sample collection and transportation

After the dromedary camels had been slaughtered in the Addis Ababa Akaki Kality Municipal abattoir, systematic postmortem exams were taken to check the presence of zoonotic hydatid cyst. Organs like liver, lungs, kidney, spleen and heart have been the most considered and, the carcass and gastrointestinal tract became additionally taken into consideration for exam. During study period only lung, liver, heart and spleen were positive, and 20 representative hydatid cyst infected samples of about $1cm^3$ in size were incised to and put into a universal tissue collector bottle prefilled with 10% buffered formalin and transported to Sabata Veterinary parasitology and pathology laboratory, Animal Health Institute. All cystic contents (germinative membrane, sandy rock water) dispatched for histopathological examination. All precautions took no longer to spill off the cystic contents once it was taking and transporting the samples to Animal Health Institute, Sabata.

3.5.5. Histopathological Examination

Representative 20 tissue samples associated with hydatid cyst in different organs (lung, liver, heart and spleen) were accrued and preserved in 10% neutral buffered formalin. The fixed tissue samples of about $1cm^3$ in size became trimmed to 5mm and processed in tissue processor (dehydrated via a chain of ascending grades of ethanol alcohol; 75%, 95%, three changes in 100% ethanol alcohol (100% I, 100% II, 100% III) cleared in three modification of xylene (xylene I, II and III) and impregnated two times with paraffin wax (paraffin wax II and paraffin wax II)) and finally, embedded in melted paraffin at 60^0c. The tissues have been then sectioned through Microtome at 5µm and stained routinely with hematoxylin and eosin, for microscopic examination (Belina *et al*., 2015).

3.5.6. Financial Impact Assessment

Only direct loss was assessed and the calculation was based on condemned organs due to hydatid cyst. By contemplating the average number of camels which were slaughtered and the degree of organ condemnation per annum become direct monetary loss attributed to metacestodes and average organ price and price index was used to calculate the loss (Getaw *et al*., 2010). Accordingly, the once a year direct monetary losses because of the hydatid cyst were expected through multiplying the average selling market price of the organs, by the average annual number of camels slaughtered, percent of hydatid cyst consistent with organ and prevalence of hydatid cyst in that study. Thus, the loss resulted from organs condemnation on the abattoir becomes assessed using the following formula;

ADFLC = (ACS* Ph*PLi* ACLi) + (ACS*Ph*PLu* ACLu) + (ACS*Ph*PHr* ACHr) + (ACS*Ph*PSpl* ACSpl). Where, ADFLC= Annual direct financial loss due to organ condemnation, ACS= Average number of camels slaughtered per year at Addis Ababa, Akaki Kality Municipal abattoir, Ph= Prevalence of hydatid cyst, ACLi= Average cost of liver, PLi= Percentage of hydatid cyst in liver, ACLu= Average cost of lung, PLu= Percentage of hydatid cyst in lung, ACHr= Average cost of heart, PHi= Percentage of hydatid cyst in heart, ACSpl= Average cost of spleen, PSpl= Percentage of hydatid cyst in spleen (Dawit *et al*., 2019).

3.6. Data Management and Analysis

The data which was collected from Akaki Kality Municipal abattoir each at antemortem and postmortem inspection were saved into Excel spreadsheet (Microsoft excel 2007). Before being subjected to statistical analysis, the data was properly coded and carefully screened for errors. Descriptive statistical analysis including frequency distributions, percent and proportion were used to summarize in table and present the collected data. Chi-square (χ^2) test was used to decide the association in zoonotic hydatid cyst and risk factors (ages, sex, body conditions score and origins). The overall prevalence was calculated by dividing the number of zoonotic hydatid cyst positive dromedary camels by the entire number of dromedary camels which were examined. For (χ^2) test, p- value < 0.05 was considered significant whereas p-value > 0.05 was considered non-significant. Logistic regression was employed to analyze association of hydatid cyst occurrence

with the potential risk factors using R studio statistical software. The degree of risk factors associated with the disease occurrence was further analyzed using odds ratio.

3.7. Ethical Considerations

The study protocol was reviewed and approved by the research ethics review committee of Addis Ababa University, college of Veterinary Medicine and Agriculture (VM/ERC/13/02/14/2022). The objective and procedure of the study were explained to Addis Ababa abattoir enterprise and Akaki Kaliti Municipal abattoir for their voluntary use of their dromedary camels and they provided permission regarding camels related studies.

4. RESULTS

4.1. Prevalence and risk factors of hydatid cyst in dromedary Camels

The number and prevalence of infected dromedary camels were shown in the table 1. It was found that from 370 examined camels, 96 (25.9%) dromedary camels were infected with hydatid cyst.

Table 1- Prevalence of hydatid cyst in dromedary camels at Addis Ababa Akaki Kality Municipal abattoir, Ethiopia (n= 370).

Examined dromedary camels	Frequency	Prevalence (%)
Infected	96	25.9
Not infected	274	74.1
Total	370	100

The distribution of hydatid cysts in different age groups, body condition score, sex and origin are illustrated in table 2. The prevalence and likelihood of occurrence of hydatid cyst was significantly (P- value=0.03) higher (29.67%; 73/246, OR= 1.54) in adult age group than young dromedary camels (18.55%; 23/124). It's true that the prevalence of hydatid cyst in adult dromedary camels was significantly (P= 0.03) higher (19.73%;73/370) than overall prevalence of young dromedary camels (6.23%; 23/370).

There was no statistically significant difference between sex group (P- value= 0.53) and origin of the camels (P value= 0.437). Out of 220 males examined, 54 camels were infected with hydatid cysts (24.5%, OR= 0.83) and from 150 female examined, 42 camels were infected (28%). The overall prevalence of hydatid cyst of males was 14.59%; 54/370 and of females was 11.35%; 28/370. Out of 146 examined camels from those came from Borana, 34 camels were positives (23.28%; 34/146) and the prevalence of hydatid cyst of camels from those came from Borana was 9.19%; 34/370.

In this study, the prevalence of hydatid cyst associated with body condition score was statically significant (P < 0.05; 0.00). Generally, prevalence of hydatid cyst in poor, medium and good body condition scores was 61.4%; 35/57, OR= 10.79, 30.89%; 38/123, OR= 3.30 and 12.11%; 23/190 respectively. The overall prevalence of hydatid cyst in regard to body condition score poor, medium and good were 9.45%, 10.27% and 6.21% respectively (table 2).

Table 2- Risk analysis of hydatid cyst by age, body condition score, sex and origin (n= 370).

Risk Factors	**Category level**	**Examined Number**	**No. of positive**	**Prevalence within group**	**Prevalence**	**P-value**	**Odds Ratio**
Age	Young (< 5 years)	124	23	18.55	6.22		Ref*
	Adult (>= 5 years)	246	73	29.67	19.73	0.03	1.54
Body condition score	Poor	57	35	61.4	9.46	0.00	10.79
	Medium	123	38	30.89	10.27		3.30
	Good	190	23	12.11	6.22		Ref*
Sex	Male	220	54	24.54	14.59	0.53	0.83
	Female	150	42	28	11.35		Ref*
Origin	Borana	146	34	23.28	9.19	0.43	Ref*
	East Hararghe	5	2	40.00	0.54		2.12
	Jigjiga	47	18	38.29	4.86		2.06
	Karrayyu	49	13	26.53	3.51		1.18
	Matahara	63	14	22.22	3.78		0.94
	Minjar-shonkora	21	4	19.05	1.08		0.78
	Wollo	39	11	28.205	2.97		1.31
	Total	**370**	**96**	**-**	**25.94**		**-**

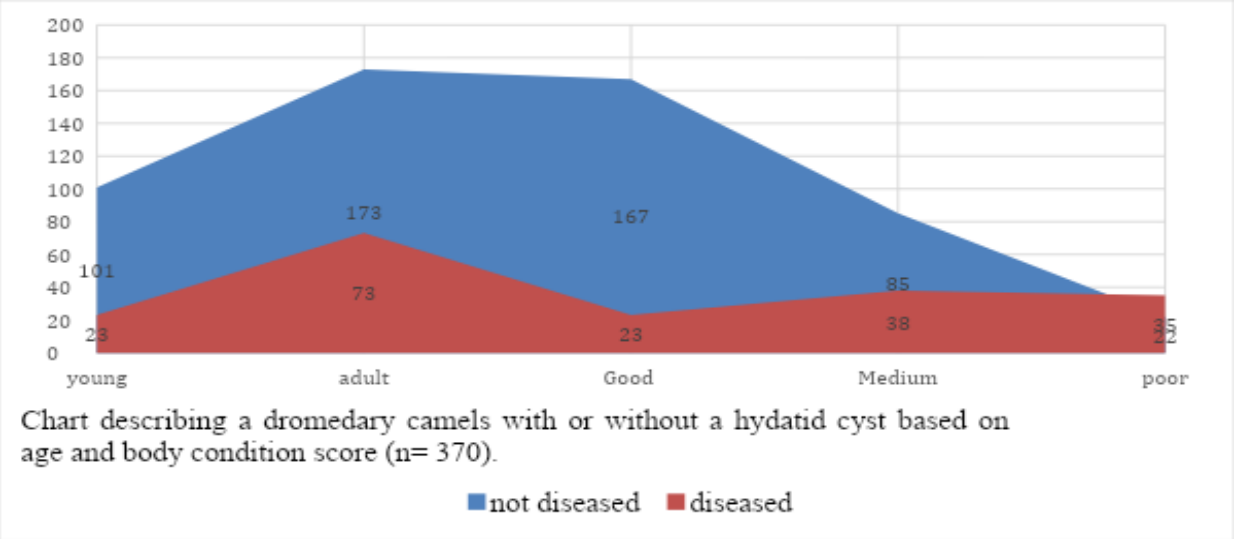


Chart describing a dromedary camels with or without a hydatid cyst based on age and body condition score (n= 370).

Figure 3 - Prevalence of hydatid cyst in relation to body condition score and age.

Out of 96 infected camels, 1 (1.04%) camel's heart, 2 (2.08%) camel's liver, 83 (86.46%) camel's lung, 9 (9.38%) camel's lung and liver, and 1 (1.04%) camel's spleen had hydatid cyst in them. Among camels infected with a cyst, 90.62% had cysts only in a single organ while the remaining 9.38 had hydatid cyst on lung and liver. The overall frequency of hydatid cyst in different organs from the total examined camel is shown in table 3 below.

Table 3- Distribution of hydatid cyst in different organs

Organs	**Numbers of infected organ**	**Percent from infected dromedary camels**	**Prevalence from total examined dromedary camels (%)**
Heart only	1	1.04	0.27
Liver only	2	2.08	0.54
Lung only	83	86.46	22.43
Lung and liver	9	9.38	2.43
Spleen only	1	1.04	0.27
Total	96	100	25.9

Out of total infected organs (105), infected lung was 92 (87.61%), liver was 11(10.47%) and the others spleen and heart were only one in number (0.95% each). Of 370 examined camels, 92 camel's lungs were infected and of these, 39 (10.54%) lungs had less than three cysts and 53

(14.32%) lungs had greater or equal to three cyst numbers. 11 camel's liver was infected from 370 examined camels and 10 (2.7%) livers had less than three cyst and 1 (0.27%) liver had greater or equal to three cyst number. Heart and spleen were the least infected (1 each) from total examined camels (370), and both heart and spleen had less than three cyst numbers (table 4).

Table 4- Prevalence rate and number of distributions of hydatid cyst per infected organs of slaughtered camels.

Organs	**Total infected organ**	**% Of infected organs**	**Prevalence from total examined camels**	**P value**	**< 3 cysts with prevalence from total examined camels**	**≥ 3 cysts with prevalence from total examined camels**
Lungs	92	87.61% (92/105)	24.86	0.00	39 (10.54)	53 (14.32)
Livers	11	10.47% (11/105)	2.972	0.00	10 (2.7)	1 (0.27)
Heart	1	0.95% (1/105)	0.27	0.5827	1 (0.27)	0
Spleen	1	0.95% (1/105)	0.27	0.5827	1 (0.27)	0
Total	105	100%	28.372	-	51 (13.78)	54 (14.59)

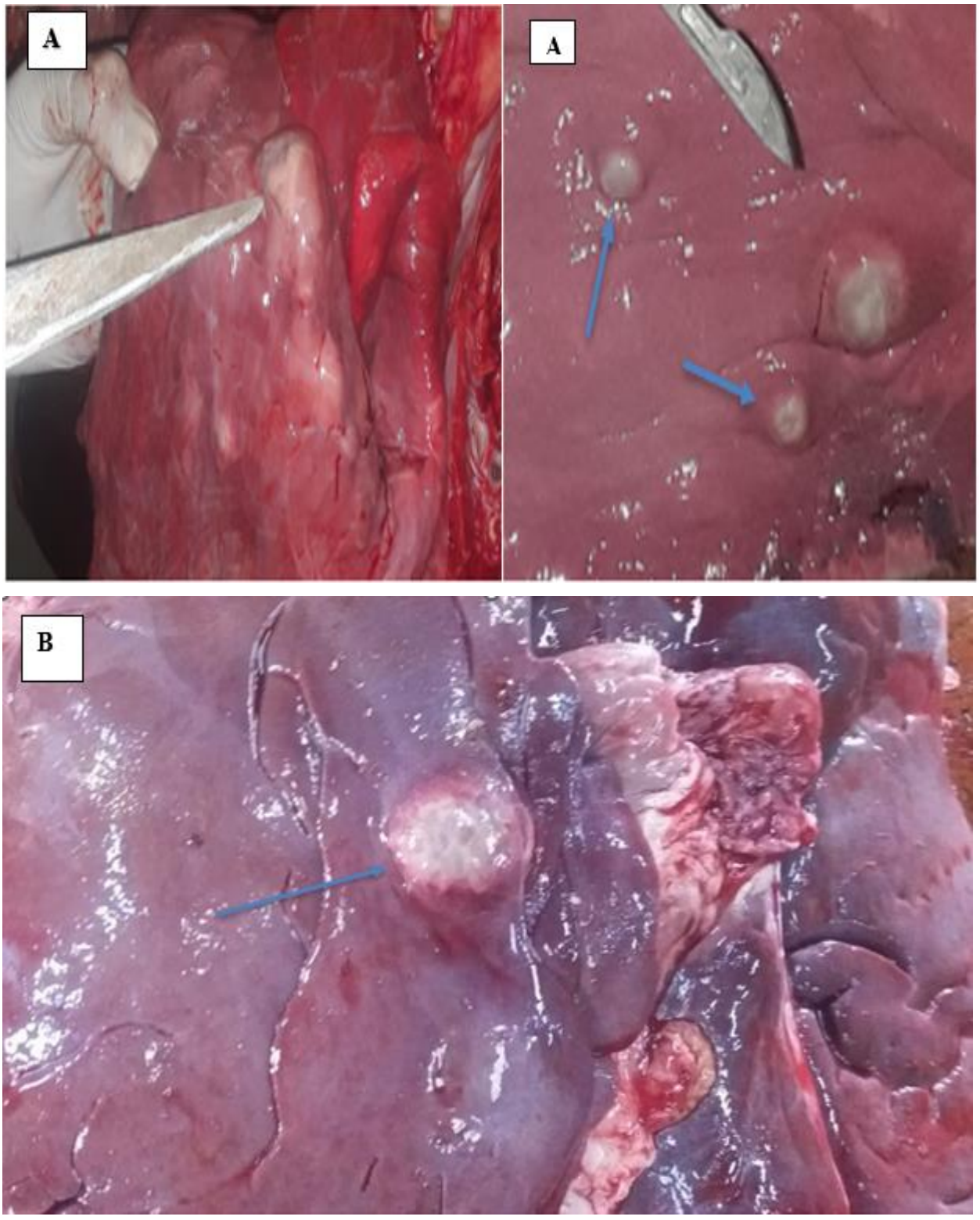
4.2. Antemortem Examination

The dromedary camels were examined in the lairage both in motion and at rest for any abnormality (fracture, emaciation and presence of external parasite) in order to exclude those positive for slaughter and different parameters (body condition score, age, sex and origin) were recorded before their slaughter. Accordingly, there were no visible clinical signs recorded to protect them from slaughtering (figure 4).

Figure 4- Antemortem examination of camels at Addis Ababa Akaki Kality Municipal abattoir, Ethiopia.

4.3. Gross Pathology

The affected organs were examined for any gross changes related to the cyst. The lung is exposed to single to multiple hydatid cysts containing fluid in the pulmonary parenchyma with different sizes. They have a shape of cotton ball and the cysts were implanted in the lung parenchyma or have been in part embedded after they have been seen from the lung surface. Dorsal and ventral portions of the lung had been affected. The cysts were filled with clean to incredibly turbid fluid, soft consistency and malleable to the touch in the lung of affected dromedary camels. Once the fluid was eliminated from the hydatid cyst of the lung tissue, the cysts collapsed and looked like an internal whitish germinal layer. Single to more than one hydatid cysts having small pea size were found from the visceral and or parietal surfaces of the liver. But, maximum cyst on livers was looking firm, calcified and hard to cut. The spleen was infected with the hydatid cysts on its dorsal part and the hydatid cysts on a spleen were doughy to the touch. Heart becomes affected with the hydatid cyst across the apex side and it has pliable consistency **(**figure 5**).**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A
B

Figure 5- Postmortem examination of hydatid cyst infected organs (A=lung, B= liver and C= heart).

4.4. Histopathology

Hematoxylin and Eosin-stained segment of lung showed the structure of hydatid cyst as outer fibrous layer (pericyst) which constitute host reaction to the parasite; has infiltrated with aggregates of lymphocytes and epithelioid macrophages cells revealing inflammatory response to cyst layers, middle acellular eosinophilic laminated membrane layer (ectocyst) and inner germinal layer (endocyst) and it changed into full of clean hydatid fluid. Segment of lung hydatid cyst fluid had protoscolices (figure 6- A and B).

Typically, Hematoxylin and Eosin-stained sections found out that the histological structure layer and infiltrated cell in hydatid cyst infected liver and heart were similar to that seen in the lung even if it had varied thickness of lamination.

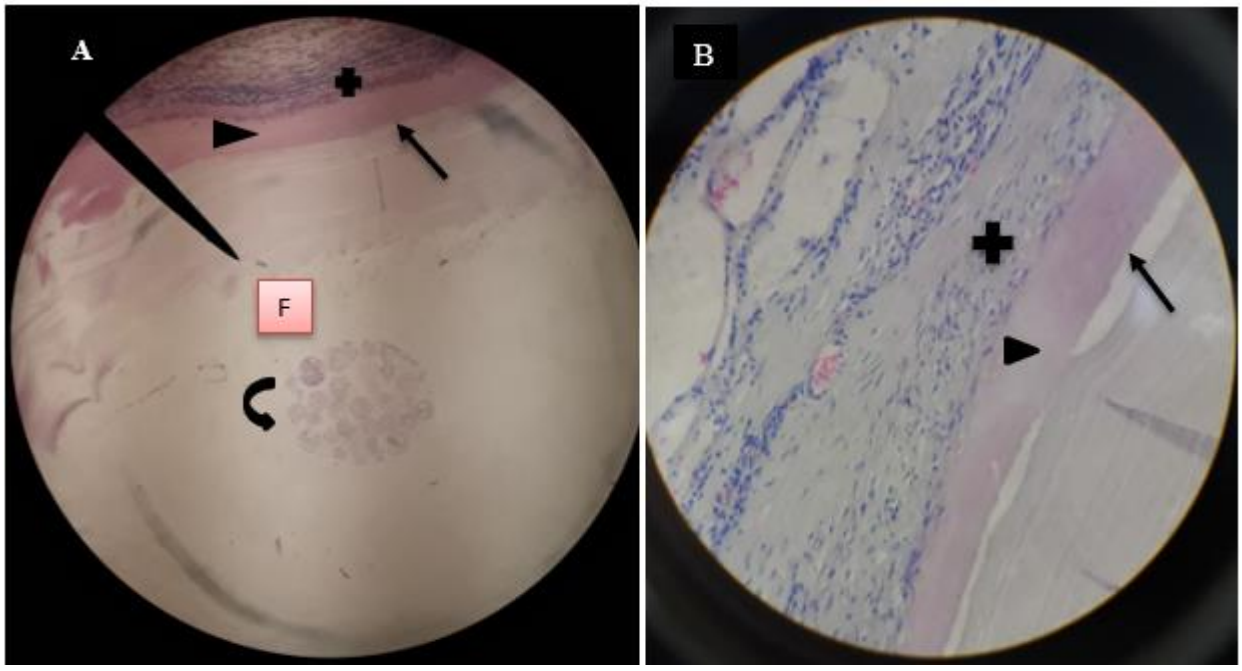
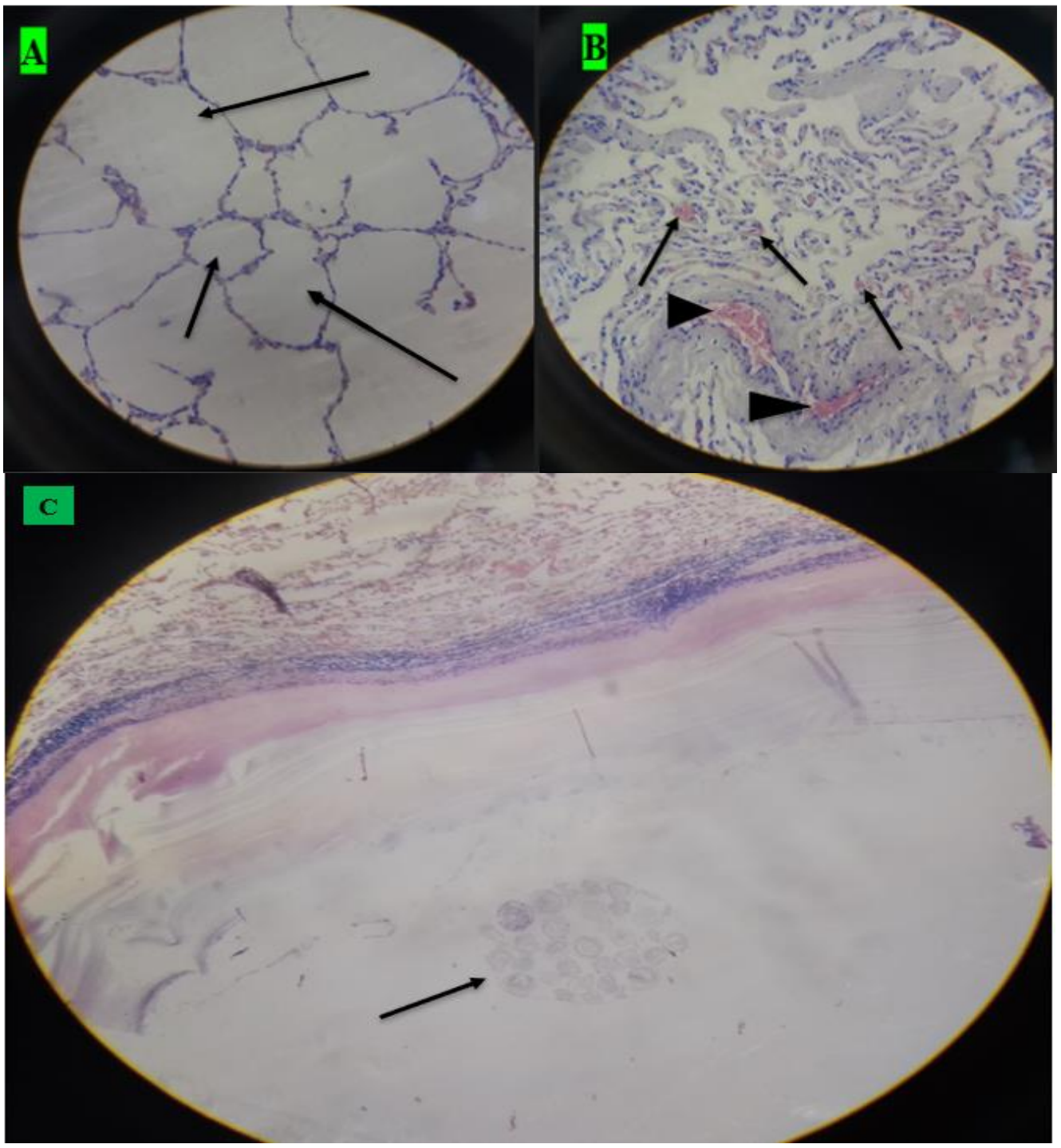


Figure 6- Histopathology of lung lesions. Microscopic finding of camel's lung suffering from hydatid cyst which shows pericyst (infiltrated with aggregates of lymphocytes and epithelioid macrophages cells revealing inflammatory response reaction to cyst layers and in to surrounding alveoli (cross shape), ectocyst; acellular laminated membrane (arrow head) and endocyst (germinal layer) (thin arrow). There was also ovoid protoscolices (curved arrow on picture A) within the fluid contained in the cyst lumen (F) (All hematoxylin and eosin, seen under 100x (A) and 400x (B).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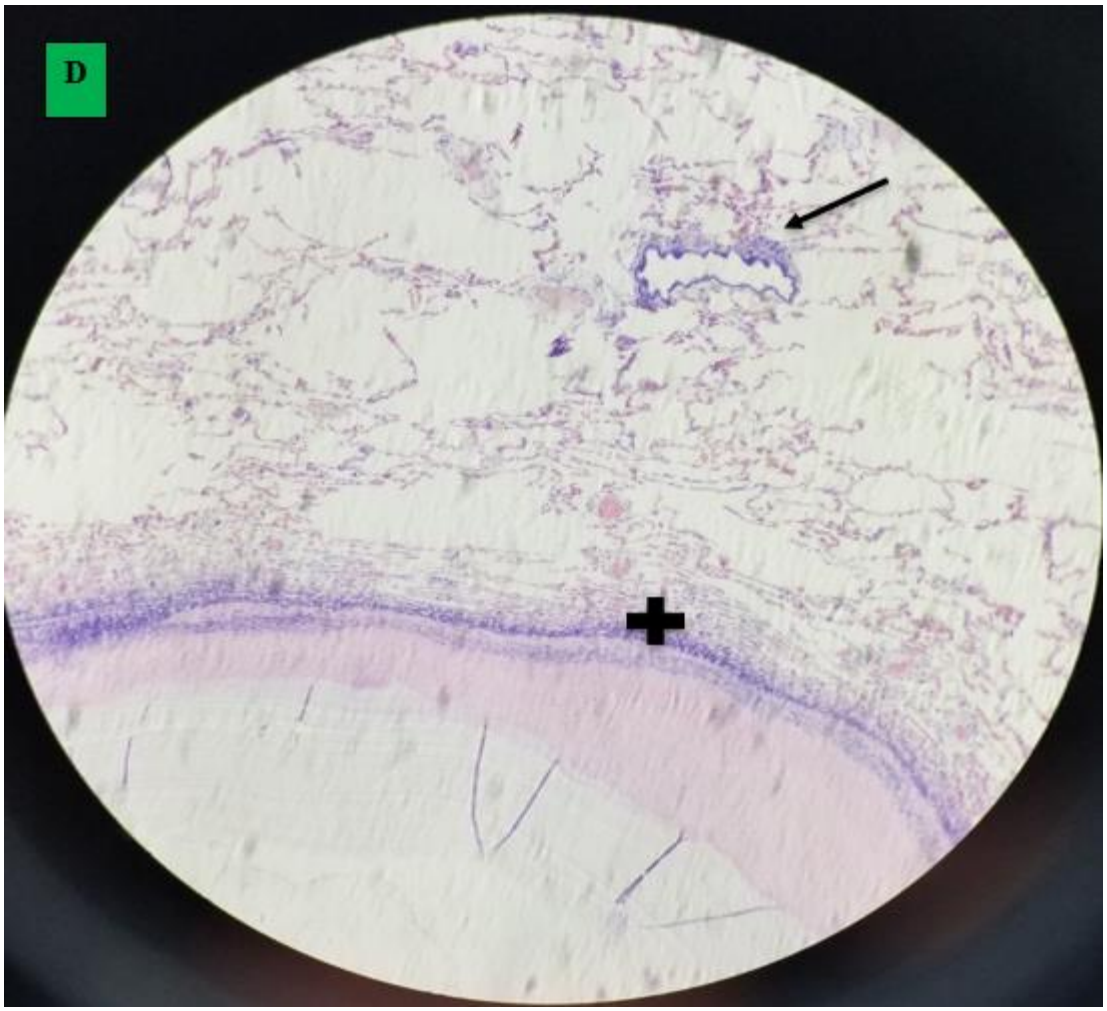


Figure 7- Histopathology of hydatid cyst infected lung. A. small cavity of alveoli structure; normal expansion of air space (small arrow) far away from cyst wall and other alveoli was emphysematous (larger arrow). B. Histopathological result of hydatid cyst in lung: inflammatory infiltrate in fibrous layer, capillary congestion (arrow head), hemorrhage (arrow), massive alveolar damage, atelectasis; collapsed alveoli (throughout slide). C. Hydatid cyst wall in lung, protoscolices (arrow). D. Hydatid cyst infected histopathology of lung with cellular infiltration surrounding bronchioles (arrow), cellular infiltration (cross) and hemorrhage (H and E stain, 400x).

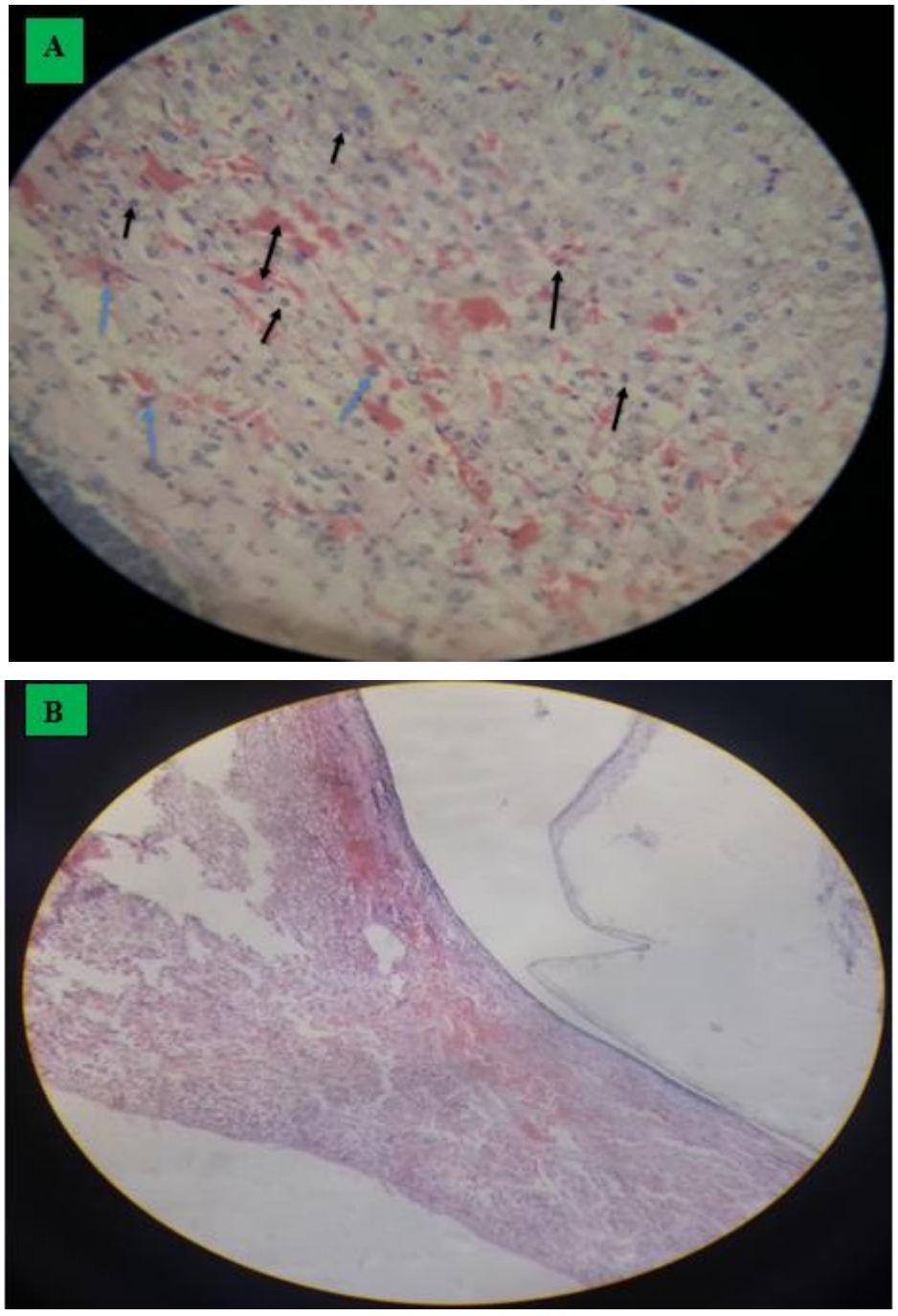
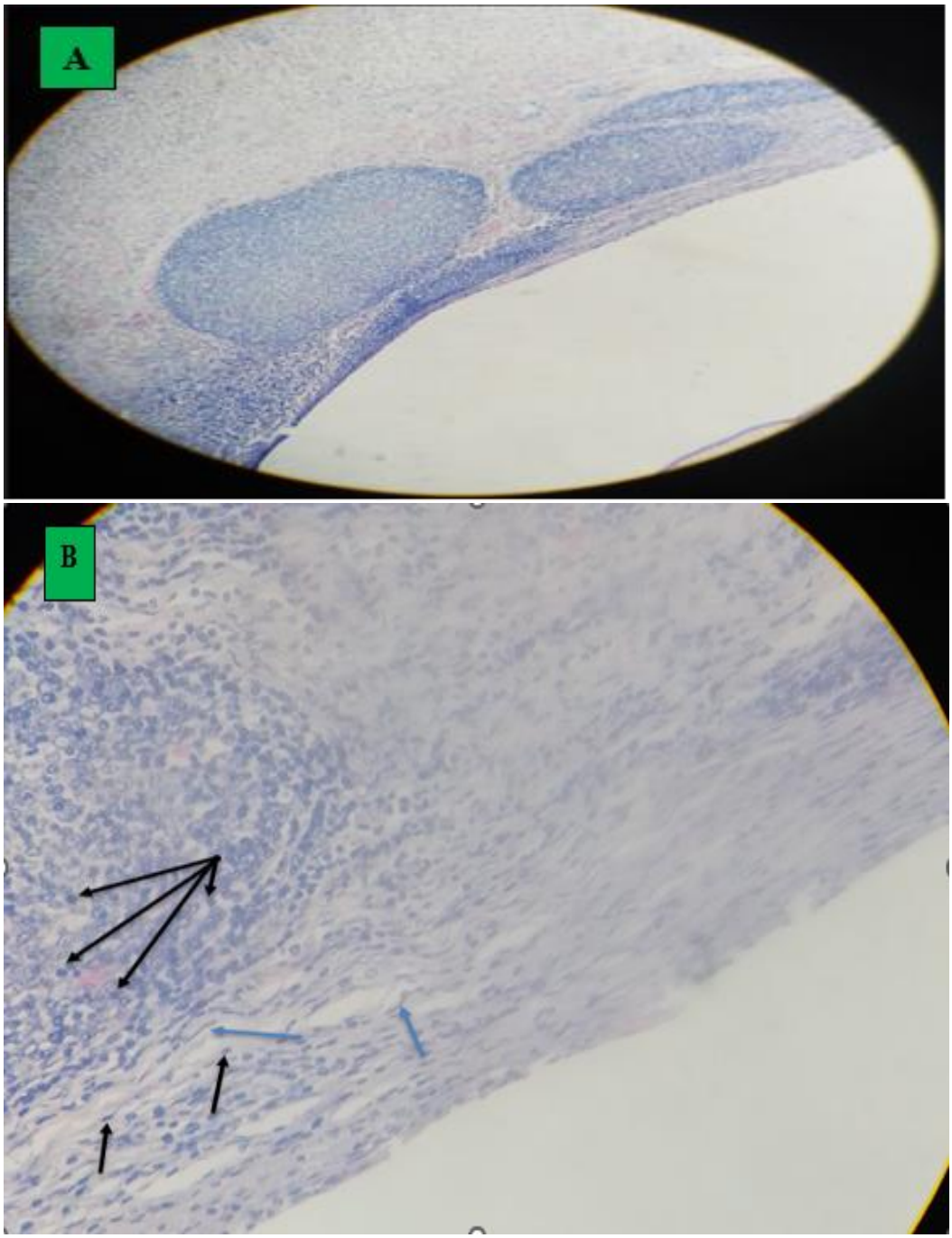


Figure 8- Histopathology of camel's liver which affected with hydatid cyst. A. Infiltration of cell: Lymphocyte (black arrow), macrophages (green arrow). There was enormous hemorrhage (double arrow) and, hepatocyte degeneration and cytoplasmic swelling with dilation of nucleus. B. Fluid of hydatid cyst which had not a protoscolices, thin lamination free of a cell, hemorrhage and cellular infiltration forms broken fibrosis (H and E stained, 400X).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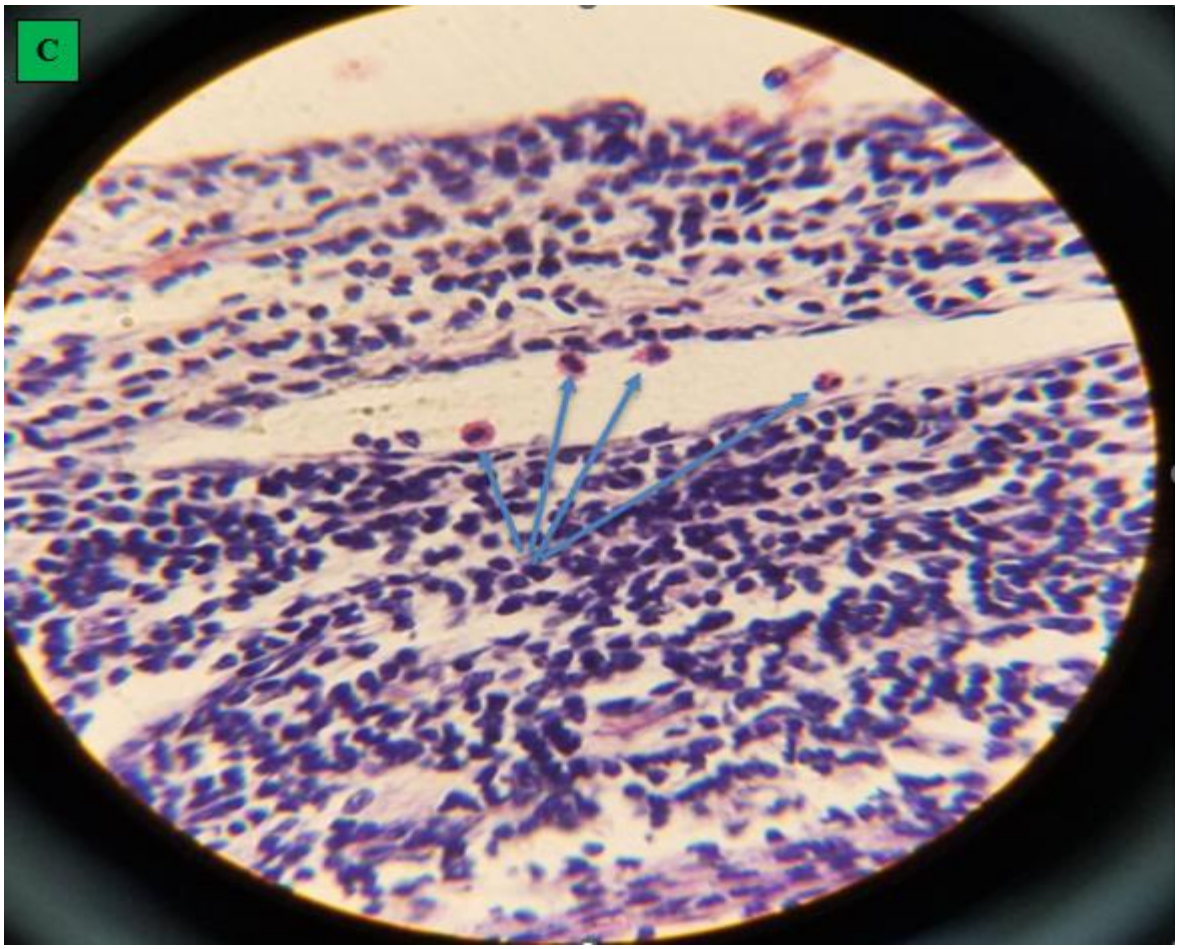

Figure 9- Histopathology of camel's liver with inflammatory cells. A. Histopathology of camel's liver which indicated inflammatory nodules. B. Inflammatory nodules with lymphocyte (dominant) (interconnected arrow) and epitheliod macrophages (black arrow), collagen fiber as wave shape (blue arrow) and fibroblast nucleus, thin lamination of hydatid cyst, hydatid cyst fluid, C. Eosinophils migration in vessels (arrow) (H and E stained, 400x).

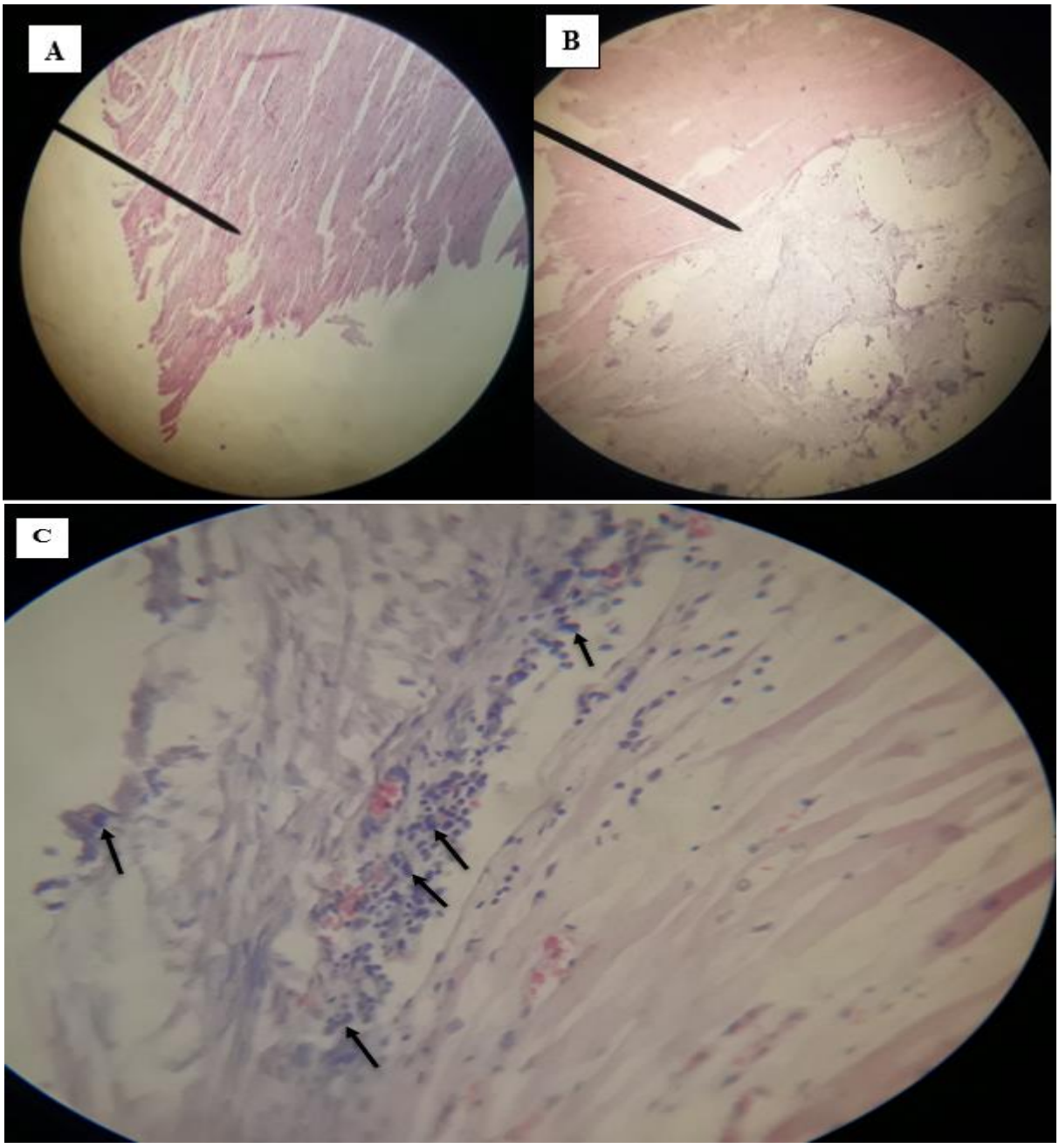

Figure 10- Histopathology of heart affected with hydatid cyst. A. Branch and anastomosis which contain a nucleus in heart muscle and interconnected with a subsequent branch at an intercalated disk. B. The hydatid cyst had not a visible protoscolexs and it had weak germinal and lamination layer followed by cellular infiltration. C. Lymphocyte (dominant) and epitheloid macrophages infiltration (arrow) (H and E stained, 100x and 400x).

4.5. Assessment of Direct Annual Financial Loss

The foremost cost of camels' organs at Addis Ababa city was gained from abattoir employees and butchers for the duration of the study period. Average marketplace cost of camel's lung, liver, spleen and heart at Addis Ababa town had been 15 Ethiopian Birr (ETB), 1000ETB, 5ETB and 120ETB respectively. The abattoir document displays that the mean yearly number of camels slaughtered in the course of the beyond three years become 2,555. Annual direct monetary loss was assessed in view of annual slaughter average of camel, proportion of affected organ and prevalence of hydatid cyst per organ and was expected to be 86,209.63ETB (1,657.8775 US Dollar), (table 6).

Table 5- Estimated annual direct financial losses due to organ condemnation in camels slaughtered at Addis Ababa Akaki Kality Municipal abattoir, Ethiopia.

Infected organ	**Number infected**	**Proportion affected**	**Prevalence of hydatid cyst**	**AANCS**	**AMP in Birr (ETB)**	**ADFL in Birr**
Heart	1	1.04% (1/96)	25.9%	2,555	120	826
Liver	2	2.08% (2/96)	25.9%	2,555	1000	13,764.29
Lung	83	86.46% (83/96)	25.9%	2,555	15	8,582.17
Lung and Liver	9	9.38% (9/96)	25.9%	2,555	1,015 (1000 + 15)	63,002.76
Spleen	1	1.04% (1/96)	25.9%	2,555	5	34.41
Total	96	100%	25.5%	2,555	2,155	**86,209.63ETB (1,637.32$)**

AANCS= Average annual number of camels slaughtered; AMP= Average market price; ADFL= Annual direct financial loss; ETB= Ethiopian Birr; USD= United States Dollar. **Note:** 1 USD= 52.651ETB; 10 August, 2022.

5. DISCUSSION

Hydatid cyst is a zoonotic helminthic parasite caused by *Echinococcus granulosus* affecting every livestock and human populations (Singh *et al*., 2010). The present study found that the prevalence of hydatid cyst in slaughtered dromedary camels at Addis Ababa, Akaki Kality Municipal abattoir, Ethiopia was 25.9%, which is comparatively less than earlier study reported as 28.7% by Hayer *et al*. (2014), 38.22% of Abebe *et al*. (2021), 61.6% by Boru *et al*. (2013), 65% by Regassa *et al*. (2015) and 65.47% by Gizachew *et al*. (2013). However, it is higher than the preceding reports 5.1% by Alembrhan and Haylegebriel (2013), 16.62% Tenaw *et al*. (2015), 18.79% by Dawit *et al*. (2019), 18.8% by Woldemeskel *et al*. (2001), 22.6% by Muskin *et al*. (2011) and 23% by Debela *et al*. (2014) from various areas of Ethiopia. The higher prevalence in the present study might be due to the presence of higher numbers of dog; a definitive host which are closely associated with camels in the field and barn, along with high population of wild carnivores in majority of study area (Borana) (Balako, 1999) and there was lack of proper condemnation of infected organs in pastoral zones (Bekele, 2008).

Higher prevalence than the current studies were likewise reported from different country such as 32.85% by Mohamed (2010) from Saud Arabia, 35.2% by Ahmadi (2005) from Iran, 59% by Omer *et al*. (2010) from Sudan, and smaller prevalence of hydatid diseases than the present studies was reported from other countries; 8.25% (Draw city) and 8.5% (Aswan city) by Dyab *et al*. (2018), 14.64 % by Mohammad *et al*. (2016) from Tabriz area, Northwest Iran and 19.49% by Ohiolei *et al*. (2019) from Nigeria. Difference of prevalence in different regions in a country might related with aspects like difference in societal activity, livestock farming system, cultural variation, high number of stray dogs, lack of responsiveness of people, lack of suitable removal of infected carcass and visceral organs, lack of systematic deworming of a dog, and approach of camels to definitive host; a dog (Garippa *et al*., 2004; Yifat *et al*., 2011). Specifically, in the pastoralist areas of Ethiopia, typically in Borana, Jigjiga and Karrayyu area, the relationship between stray dogs and camels is very close. This causes the hydatid cyst to be more widespread than elsewhere.

In present study among one humped camel harboring hydatid cyst, lungs have been the most commonly affected visceral organs (87.61%; 92/105) followed by liver (10.47%; 11/105) and the remaining affected spleen (0.95%; 1/105) and heart (0.95%; 1/105) were minimum in proportion. From standard examined whole camels (370), organ distribution of cyst became 22.43% in lungs alone, 2.43% in both lung and liver whereas the remaining infected organs were less percent (0.54%, 0.27% and 0.27% in liver, spleen and heart alone respectively). This study is consistent with Abo El-Ala (2014), Dyab *et al*. (2018) and Fathi *et al.* (2012).

Lung infection with hydatid cyst was statistically highly significant in association with other predilection sites (P value < 0.05; 0.00). In the same way, the lung was most commonly infected with hydatid cyst because of its magnitude, blood supply and accessibility of oxygen source. Besides, this finding is in agreement with the literature that showed hydatid cyst is most commonly found in lung and liver of camels; 49.4% in lungs alone, 30.0% in both liver and lungs, 14.6% in liver only and 6.0% in other organs ((Tenaw *et al*., 2015;) Rokni, 2009). Lungs and livers were the most infected with hydatid cyst than any other organ probably due to the occurrence of larger capillary beds than any other organs (Kebede *et al*., 2009). This might decrease the prevalence of hydatid cyst in other organs like heart and spleen during the study period. Though, an advanced rate of liver infection than lung became described from Ethiopia by Boru *et al*. (2013) and Haridy *et al*. (2006) might be due to the period of their study was two years (2010-2013), which is longer than the current study period, and another is that there were many camels studied during their study period (770). Also, almost all hydatid cyst infected camels (472) were slaughtered at an older age. During this period the liver capillaries is dilated and most oncospheres pass directly and used for hexacanth embryo to enter the lymphatic circulation at last that can be carried through the thoracic duct to the lung (Bekele and Butako, 2011).

In the current study, the highest number of hydatid cyst per infected organ was recorded in the lung (less than three cysts 10.54%; 39/370 and greater or equal to three cysts 14.32%; 53/370) than liver (2.7%; 10/370). Spleen and heart had only less than three cyst numbers. Such differences in cyst quantity might be due to the spatial distribution and the infectivity of *E. granulosus* eggs and the exposure and self-protective capabilities of the host that agree with the

study of Macpherson *et al.* (1985). Likewise, the high number of hydatid cysts in the lung may be due to the relatively softer consistency of lung compared to the liver. The lung tissue is softer in consistency and allows the easier development of the cyst than the liver tissue (Dyab *et al*., 2018). Small amount of hydatid cyst from the livers and caused it to become a calcified cyst was due to relatively the number of reticuloendothelial cells was high and connective tissue reaction of organs was ample. There was also a small hydatid cyst on the liver at the time of the study and it became supposed that the immunological response of the host avoids it from widening in extent (Larrieu *et al*., 2001; Torgerson, 2002).

In the present study, the degree of hydatid cyst prevalence within a male (24.55%, 54/220) and females (28%; 42/150) was not statically significant (P value= 0.53, OR= 0.83). But there was smaller prevalence in male than female camels. This is in line with the study of Rokni (2009) which reported that the degree of prevalence between males (34.4%) and females (36.6%) was not statistically significant. Also, Mohammad *et al*. (2016) reported that there were no significant differences found between male and female rates. However, the present study did not agree with the study of Boru *et al*. (2013) and Abebe *et al*. (2021), which reports as the prevalence of hydatid cyst was significantly higher in female camels (61.8%) than the male camels (40%). This might be due to a higher number of females (760) than male camels (only 10) were inspected during the previous study of Boru *et al*. (2013). This was probably caused the significant effect of hydatid cyst with sex because when a female camel came to the house area for milking, it directly or indirectly comes into contact with the dog which is definitive host of hydatid disease.

There was significant variation (P= 0.03, OR= 1.54) in camels with different age groups where hydatid cyst was higher in adult camels (greater or equal to 3 years old) with the prevalence within age group of 29.67%; 73/246 and 18.55%; 23/124 in young (smaller than 3 years old). This study agrees with the previous study of Azlaf and Dakkak (2006) and Osman and Abdalla (2013). Also, Dyab *et al*. (2018) found that there was a statistically important difference ($P<0.05$) in camels with different age groups where adults were highly infected with the prevalence of 61.25%; 49/80 and young camels have only 6.2%; 124/2000 prevalence. The hydatid cysts raise gradually and take quite a lot of years to grow big enough and form symptoms (WHO/OIE, 2001) and also hydatid cyst larva develop very slowly, and its fertility is only acquired in 12 to

18 months after ingestion of eggs (Soule, 1994). For that reason, the inspected young camels (aged less than three years old) show no observable hydatid cyst. Similarly, this age difference can be again associated with variation in exposure to infection because older livestock may have been exposed to more infective stages than young animals (Ibrahim *et al*., 2008). Adult camels might be exposed more to infective stages and a higher number of adult camels (246) than young camels (124) were slaughtered in their old age.

Analysis of body condition scores of camels had significant association ($P<0.05$) per the existence of hydatid cyst and there was advanced likelihood of existence of hydatid cyst in poor body conditioned dromedary camels (OR=10.79). Camels with poor body condition had higher prevalence (61.4%) than medium (30.89%) and good (12.11%) body conditions. The difference between body conditions score may be because camels with poor body conditions have weak immunity to hydatid disease and extended exposure time to eggs of *E. granulosus* which agrees with the prior described study of Etana *et al*. (2015). In moderate to severe infections, the parasite might be causes retarded performance and growth, reduced quality and yield of milk and meat (Polydorou, 1981).

The present finding revealed there was no statistical variation (P value= 0.43) in the prevalence rates between the areas where the examined dromedary camels originated (Borana, East Hararge, Jigjiga, Karayyu, Matahara, Minjar Shenkora and Wollo). The reason for the absence of variation in prevalence from those camels that came from different places may be related with the presence of very similar environmental situations. This study is consistent with the study of Hayer *et al*. (2014) and Regassa *et al*. (2015) which conveyed that there was no statistical difference ($P> 0.05$) in prevalence rate of hydatid cyst between study areas. The reason for the absence of an important difference in the prevalence in those different places might be associated with the existence of very similar ecological conditions from the major origin of slaughtered camels; Jigjiga, East Hararge, Borana and Matahara.

In the current study, there was gross expansion of affected organs, appearing as a couple of solid to soft on touch, tumor like cysts developing on the inner and outdoor parenchyma of affected organs and it was in line with the result of Romig *et al*. (2011). Mostly, affected lung had big

sized cyst of soft consistency which had a shape of tennis ball, the cysts have been filled with clear to noticeably turbid fluid and moreover spleen and heart had soft whitish cyst while liver had small pea sized solid cyst were observed from the visceral and parietal surfaces of the liver. Similar findings were stated from other study areas by investigators (Akeel *et al*., 2017a, Canda *et al*., 2003, Ibrahim and Gameel, 2014 and Rashed *et al*., 2004).

In present study, histopathology of hydatid cyst infected organs (lung, liver, heart and spleen) had three parted structures called pericyst (outer adventitial layer), ectocyst (laminated layer eosinophilic in nature) and endocyst (thin inner germinal layer). In the most inspected segment of organs, the parasitic membranes (laminated membrane and germinal layer) were clearly seen in histopathology of lung. Endocyst membrane is the thinnest, small and translucent which produces and surrounds the cyst fluid. In this study, laminated membranes had varied thickness and number of laminations. Proliferation of monocyte-macrophage systems were stimulated by cuticular membranes. This finding is in agreement with the previous study of Canda *et al*. (2003) reported as the wall of hydatid cyst has three distinct layers; the outer acellular laminated membrane, germinal membrane and protoscolices and hydatid cyst might be walled by either a fibrous capsule or granulation tissue including inflammatory infiltrate.

In current study, the microscopic examination indicated that the tissue section (lung, liver, heart and spleen) had signs of reaction among the host (cellular) and hydatid cyst, characterized by fibrous layer infiltration with lymphocyte (dominant), epithelioid macrophages and eosinophils. Lung of hydatid cyst infected camels displayed massive alveolar damage, some alveoli was emphysematous, capillary congestion, hemorrhage and atelectasis; collapsed alveoli. Hydatid cyst layer was responded to by inflammatory reactions (lymphocytes and epithelioid macrophages) which decreased as they far away from the cyst layer. The inflammatory reaction regularly moved into the surrounding alveoli and small bronchioles. Typically, a hydatid cyst infected liver showed infiltration of inflammatory cells and nodules formation with intermixed lymphocyte (dominant) and epithelioid macrophages, collagen fiber and fibroblast nucleus and thin lamination of hydatid cyst. Enormous hemorrhage, hepatocyte degeneration and cytoplasmic swelling with dilation of nucleus in fibrous layer was another finding. Branch and anastomosis which contain a nucleus in heart muscle and interconnected with a subsequent branch at an

intercalated disk and the cyst had not a visible protoscolices and it had weak germinal and lamination layer followed by lymphocyte (dominant) and epithelioid macrophages infiltration. This finding is in line with Akeel *et al*. (2017a), Akeel *et al*. (2017b), Dyab *et al*. (2020) and Khadidja *et al.* (2014).

The current study indicated that less financial losses; 86,209.63ETB (1,637.32 US Dollar**),** were recorded due to organ condemnations than the previous study of Dawit *et al*. (2019), reported as 142, 133.55ETB (5214.95US Dollar) and Gizachew *et al*. (2013), estimated the financial loss as 1,089,758.8ETB (61,222.4 US Dollar). This less economic loss was due less hydatid cyst prevalence (25.9%) than that of Gizachew *et al*. (2013) (65.5%), and hydatid cyst had higher proportion in only lungs (86**.**46%) than only livers (2.08%) when compared to the previous study of Dawit *et al*. (2019) (proportion of infected only lung and liver was 51.28% and 32.05%, respectively which might be resulted in higher annual direct financial losses than the present study. But all hydatid cyst infected organs are equally important to transmit toward a definitive host (dog and wild carnivorous). So that attention should be made to control and prevent the camel hydatid cyst.

6. CONCLUSION AND RECOMMENDATIONS

In conclusion, the prevalence of hydatid cyst of dromedary camels slaughtered at Addis Ababa Akaki Kality Municipal abattoir, Ethiopia was 25.9%. Age and body condition score were the associated risk factors and play a role in the likelihood of yielding hydatid cyst. Hydatid cyst was most commonly found on the single organ of camels. Percentage distribution of hydatid cyst was higher in the lung than the liver. According to systematic meat inspection conducted, many visceral organs had a cyst number of three or more. Grossly, a hydatid cyst of lung shaped like a cotton ball, implanted in the lung parenchyma, filled with clear to slightly turbid fluid, soft to touch and whitish inside. However, in the liver it was firm, calcified and hardened when cut. Histopathological study of hydatid cyst in dromedary camels allowed us to identify the structural layers of this zoonotic parasite in to three structures on infected visceral organs namely; fibrous layer, an acellular laminated membrane layer and germinal layer from external to internal respectively. Fibrous layer had infiltration of lymphocytes, epithelioid macrophages and eosinophils indicative of inflammatory reaction response for the cyst layer. The number of infiltrated cells becomes smaller as it moves away from the cyst layer. Total annual direct financial loss on the study area reduces the economy of the country, Ethiopia.

According to the above conclusion, the following recommendations are given:

- ✔ Society of the study area should keep camel health management.
- ✔ Camel owner need to be divided their camels based on age and body condition scores to prevent them from a hydatid disease.
- ✔ It is obligatory to teach a society about the life cycle and significance caused by hydatid cyst on animals and humans.
- ✔ More studies and research on hydatid cyst of dromedary camel should be conducted by veterinarian in different parts of Ethiopia to continue and deepen this study by molecular characterization, know economic loss, clarify the epidemiological role of different animals in the transmission of the cyst in the regions and so as to provide effective prevention.

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8. ANNEXES

Annex 1- The way of collecting raw data was coded and entered on Microsoft Excel 2007.

1) Diseased= 1, no diseased= 0
2) Body condition score of the dromedary camels were scored and coded, respectively as:
    a) Poor= score 0 and 1, = 0
    b) Medium= score 2 and 3 = 1
    c) Good= score 4 and 5, = 2
3) Age of the slaughtered dromedary camels were grouped and coded as:
    a) Less than five years= young= 0
    b) Greater than or equal to five years= adult= 1
4) Sex of studied dromedary camels were coded as;
    a) Female= 0
    b) Male= 1
5) Distributions of hydatid cysts on an organ
    a) No cyst found = 0
    b) Less than three cysts= 1
    c) Greater than or equal to three cysts = 2
6) Dromedary camels which came to Addis Ababa abattoir enterprise, Akaki Kality, Ethiopia were originated from different parties of a country and coded as the following:
    a) Borana= 0
    b) EastHararge= 1
    c) Jigjiga= 2
    d) Karrayyu= 3
    e) Matahara= 4
    f) Minjar shenkora= 5
    g) Wollo= 6

Annex 2- Histopathological steps which undergone during the current study was:

a. Sample Acquisition (acquiring) and management

- Desired sample was identified and removed rapidly and atraumatically by using sharp and clean scalpels into a universal bottle and then labeled soon.

b.Fixation

- 10% buffered formalin was filled into a universal bottle; 10X times the volume of the tissue block.

c.Trimming

- After fixation tissues were cut up so that the area of interest fitted in to standard histological processing cassettes and the tissue identity is written with soft pencil on small paper and put into tissue cassette

d. Up to the tissue processing started the tissue cassettes were put into the 10% buffered formalin.

e.Tissue processing (include 4 steps)

1. Fixation: 10 buffered formalin
2. Dehydration:
    a) 75% ethanol alcohol
    b) 95% ethanol alcohol
    c) 100% I ethanol alcohol
    d) 100% II ethanol alcohol
    e) 100% III ethanol alcohol
3. Clearing:
    a) Xylene I
    b) Xylene II
    c) Xylene III
4. Impregnation:
    a) Paraffin wax II
    b) Paraffin wax II

Note: Open type tissue processor stopped after 20 hours and 11 minutes.

f. Embedding:

i. On completion of processing, the tissue was removed from their cassettes, one at a time only, with heated forceps and placed face down in a steel mould and plastic embedding cassette was placed on tissue which was in the steel mould.

ii. Molten wax was poured into the mould.

g. Microtomy (Sectioning):

1. Ribbons (thin sections, 1–5 microns (μm) in thickness) were produced from paraffin wax-embedded tissue blocks. At the beginning sections were removed at 10–15 μm intervals, until the full face of the tissue was available, followed by several sections at 4–5 μm to ensure a smooth block surface.
2. The ribbon of sections was supported, removed from the knife edge and floated on to a 48–500C water bath.
3. The sections were attached to glass microscope slides by part submersion of the slide in the water.
4. Generally1 to 2 sections were attached to a slide from each block
5. The slide was then placed in the oven to facilitate adhesion of the paraffin wax section to the glass.
6. Sections were ready for staining by hematoxylin and eosin (H&E).

h.Staining

Basic steps in staining and mounting paraffin sections were as follows:

i. Deparaffinization:

1.Cleaning by xylene two changes, each for five minutes

2.Hydration; in descending series of alcohol (100% alcohol two times, 95%, and 70% alcohol each for three minutes and then rinse in water.

ii. Staining:

1.Stained in hematoxylin for 15 minutes and rinsed in water.

2.Stained in eosin for one minute and other slides were dip in eosin three times, and after staining in eosin, quickly proceeded for dehydration.

iii. Dehydration: increasing concentration of alcohol; dip the slide in 70% alcohol for one minute and other slides were dip into alcohol three times, dehydrate in 95% alcohol for one minute and 100% alcohol three changes each for three minutes.

iv. Clearing: xylene (three changes)
    a) Xylene I for five minutes
    b) Xylene II five minutes
    c) Xylene III five minutes
v. Mounting: DPX mountant. After mounting, rinse in xylene to remove surrounding oil
vi. Microscopic examination.