THE IMPACT OF METACESTODES IN RUMINANTS SLAUGHTERED AT DEBRE BERHAN MUNICIPALITY ABATTOIR, CENTRAL ETHIOPIA

MSc. Thesis

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June 2020

Debre Berhan, Ethiopia

THE IMPACT OF METACESTODES IN RUMINANTS SLAUGHTERED AT DEBRE BERHAN MUNICIPALITY ABATTOIR, CENTRAL ETHIOPIA

A Thesis Submitted to the Department of Animal Sciences, College of Agriculture and Natural Resource Sciences, School of Graduate Studies

DEBRE BERHAN UNIVERSITY

In Partial Fulfillment of the Requirements for the Degree of Master of Science in Animal Production

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June, 2020

Debre Berhan, Ethiopia

SCHOOL OF GRADUATE STUDIES

COLLEGE OF AGRICULRURE AND NATURAL RESOURSE SCIENCES

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This is to certify that the thesis entitled **"The impact of metacestodes in ruminants slaughtered at Debre Berhan municipality abattoir, central Ethiopia"** submitted in partial fulfillment of the requirement for the degree of Master of Science in Animal Production of the Graduate Program of the College of Agriculture and Natural Resource Sciences of Debre Berhan University is a record of original research carried out by **Dawit Akeberegn (ID. No. PGR/044/11)** under our supervision and no part of the thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation have been duly acknowledged. Therefor, I recommend that it to be accepted as a fulfilling to the thesis requirement.

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College of Agriculture and Natural Resource Science

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Thesis approved by

DGC	Signature	Date

Certification of the final Thesis

I hereby certify that all the corrections and recommendations suggested by the Board of Examiners are incorporated in to the final Thesis "**The Impact of Metacestodes in Ruminants Slaughtered at Debre Berhan Municipality Abattoir, central Ethiopia**" by

Name of the Designate	Signature	Date

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STATEMENT OF THE AUTHOR

I declare that this thesis is my genuine work and that all sources of materials used for this thesis have been profoundly acknowledged. This thesis has been submitted in partial fulfillment of the requirement of Master of Science at Debre Berhan University and it is deposited at the University library to be made available for users under the rule of the library. I intensely declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma or certificate.

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Date of submission: 10th June 2020__

ACKNOWLEDGEMENTS

It is the grace, mercy, charity, forgiveness, help and kindness of the Almighty God, Jesus Christ, which made me still alive, achieve this success and strength and go through all the difficult times. The generous cooperation of many people has contributed for the success and completion of this thesis. My special gratitude goes to my academic advisor Dr. Kassa Demissie, whose work ethics is worth modeling, for his commitment on the thesis at each stage and for making invaluable comments and suggestions. His utmost support is highly appreciated. I would like to express my deep appreciation to my co-advisors Dr. Dereje Tadesse and Dr. Abebe Agonafir for their unreserved effort to provide me constructive comments and suggestions. It is also a great pleasure to express my gratitude to my families, Sewunet Ayele, Sharew Akeberegn and Tigist Akeberegn for their overall support and being with me throughout the study period.

Next, I would like to thank my friends Moges Yirgabele, Abiot G/Kirstos and all others for their encouragement and moral support over the year of the thesis.

Last but not least my appreciation also goes to Debre Berhan town Administration Abattoir Workers, animal health department members at DBU and other officials for availing the necessary information indispensable for the study.

ABBREVIATIONS AND ACRONYMS

Ag-ELISA	Antigen-capture Enzyme Linked Immune-Sorbent Assay
AMI	Antemortem Inspection
BCS	Body Condition Score
CDC	Center for Disease Control
CE	Cystic Echinococcosis
CI	Confidence Interval
CNS	Central Nervous System
CSF	Cerebrospinal Fluid
CT	Computed Tomography
EC	Ethiopian Calendar
EHNRI	Ethiopian Health nd Nutrition Research Institute
ELISA	Enzyme Linked Immunosorbent Assay
ETB	Ethiopian Birr
FAO	Food and Agricultural Organization
ID	Identification
ILCA	International Livestock Center for Africa
MRI	Magnetic Resonance Imaging
MSU	Mississippi State University
OIE	International Office des Epizooties
PMI	Postmortem Inspection
WHO	World Health Organization
χ^2	Chi-square

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The Impact of Metacestodes in Ruminants Slaughtered at Debre Berhan Municipality Abattoir, central Ethiopia

By

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ABSTRACT

Metacestodes are known to have veterinary and medical importance in different parts of the world. A cross-sectional study was employed from November 2019 to April 2020 at Debre Berhan to determine the prevalence of metacestodes in ruminants slaughtered at Debre Berhan Municipality abattoir, Amhara Region, central Ethiopia. Active abattoir survey, retrospective investigation of abattoir records and face-to-face questionnaire administration were instruments of data collection. Putative risk factors precipitating the occurrence of metacestodes were identified in ruminants. The overall prevalence of metacestodes of cattle, goats and sheep slaughtered at Debre Berhan municipality abattoir was found to be 10.8% (83/768). The prevalence of metacestodes in cattle, goats and sheep was found to be 10.40% (72/692), 17.86% (5/28) and 12.50% (6/48), respectively. The prevalence of C. bovis was estimated to be 1.3% (9/692). The prevalence of bovine hydatidosis in the present study was found to be 9.1% (63/692). Higher prevalence was recorded in cross breed (17.19%) than local breed (8.28%) cattle. Cyst prevalence was recorded in 1.69% of young and 10.63% of adult animals. Higher cyst prevalence was recorded in animals with poor body condition (15.71%) followed by medium (9.47%) and good body condition scores (4.41%). The overall prevalence of hydatid cyst in both goats and sheep was found to be 11.84% (9/76). However, prevalence of hydatid cyst was 14.28% (4/28) in goats and 10.42% (5/48) in sheep. The prevalence of hydatid cyst was slightly higher in goats than sheep. The prevalence of C.cerebralis in this study was 2.63% (2/76). C. bovis and hydatid cysts were found to be distributed in different organs of cattle. The retrospective meat inspection data analysis of 26246 slaughtered cattle over the last three and half years showed an overall prevalence of 9.30% (2441/26246). The prevalence of C. bovis was *found to be 0.62% (162/26246) while that of hydatid cyst was shown to be 8.68% (2279/26246). Based on data on the number of cattle condemned organs during the study period and their average retail market price, the direct economic loss was estimated to be 132, 645 ETB. The indirect economic loss was found to be 177,976,077.55 ETB. The total economic losses in the last three and half years due to bovine cysticercosis and hydatidosis in Debre Berhan municipality abattoir was calculated based on the summation of direct economic loss due to organ condemnation and indirect economic loss due to carcass weight loss and it was found to be 178,108,722.55 ETB. There was low level of community awareness and perception at Debre Berhan town towards the transmission of zoonotic tapeworms to humans which was attested by their consumption of raw beef, raw and partially cooked beef and partially cooked beef. Volunteer respondents in Debre Berhan town indicated 33% of them acquired T. saginata, 44% of them did not have knowhow about zoonotic tapeworms and the other 58% of the respondents did not know about the fatality of tapeworms.The present study clearly demonstrated the occurrence of ruminant metacestodes in moderate prevalence in Debre Berhan town which warrants one health approach to institute rational control interventions. Further detailed study in large population over longer duration is recommended.*

Key Words: Debre Berhan, Ethiopia, Economic loss, Metacestodes, Prevalence, Ruminants Zoonosis

1. INTRODUCTION

The livestock population of Ethiopia is estimated to be 57.83 million cattle, 28.89 million sheep, 29.70 million goats, 60.51 million poultry, 2.08 million horses, 7.88 million donkeys, 1.23 million camels and 0.41 million mules. However, Ethiopia's great livestock potential is not properly exploited due to different factors such as traditional management system, limited genetic potential, shortage of feed in quality and quantity, lack of appropriate disease control policy and appropriate veterinary services. Foods of animal origin are often the preferred source of protein. However, if not properly prepared or handled, they can lead to food-borne infections. The enormous losses caused by helminth parasites which are **'the silent predators'** are intolerable in a country like Ethiopia who confronted with challenges of an ever-rising human population and food shortage. Moreover, these diseases are also known to cause public health problems as humans can be infected from accidental ingestion of parasite eggs/larvae passed into the environment with faeces from definitive hosts (Worku, 2017).

Smallholder farmers have limited knowledge of livestock management. The high number of rural farming communities in developing countries including Africa with limited or no access to toilets exacerbates the infection risk of Taenia species. Furthermore, environmental burdens of infectious organisms remain unresolved because of the limitations to sanitation facilities and manure management strategies which result in poor and declining water quality. Free-range production system combined with open field defecation by humans is a condition in which animals can get infection with Taenia eggs due to their access to human excreta during grazing. Most of the farmers in developing countries let their animals roam freely during the day for grazing and scavenging. Moreover, they use streams as the water source for their animals which may create an infection opportunity through ingestion of Taenia-contaminated herbage or water. Farmers slaughter animals for their own consumption without inspecting meat for cysticercosis. Similarly, studies conducted else where in the world have also shown that having most or all animals grazing is a risk factor for bovine cysticercosis. Backyard slaughtering, consumption of uninspected meat by the public, poor livestock management, and limited sanitation in rural communities are identified as risk factors associated with the occurrence of Taeniosis infections (Tsotetsi-Khambul *et al*., 2018). Taeniosis has been ranked as the most important food-borne parasitic disease of humans in terms of public health, socio-economic and trade impact (Worku, 2017). *T. saginata* is a cosmopolitan parasite found in developing as well as industrialized countries (Tsotetsi-Khambul *et al*., 2018).

Taeniosis and cysticercosis are foodborne parasitic zoonotic infections caused by adult tapeworms and metacestodes of human Taenia spp., respectively. These are diseases of high medical and veterinary importance due to their impact on public health and rural economy in tropical countries (Tsotetsi-Khambul *et al*., 2018). The adult tapeworm in definitive hosts is harmless unlike the metacestodes in intermediate host animals. Metacestodes are responsible for immense economic and medical importance in infected hosts (Worku, 2017). Some of the metacestodes are not only zoonotic but also are responsible for severe tissue damage, reduction in milk and meat production, and considerable economic loss due to condemnation of infected organs of the herbivorous animals (Oryan *et al*., 2012).

Taenia saginata (*T. saginata*) or bovine cysticercosis is one of the major parasitic diseases transmitted by eating raw or undercooked meat infected with the cyst stage of *Cysticercus bovis.* It does not only lead to economic loses but also adversely affect public health because humans acquire infection by inadvertent consumption of ova or larval stages (metacestode) present in raw and undercooked meat containing *cysticerci*. *C. bovis*, the metacestode of *T. saginata*, occurs only in beef. In order for animals to become infected with the intermediate stage (cysticercosis) of a Taenia tapeworm that infects humans, they must have contact with faeces from an infected person (Oryan *et al.*, 2012; Nunes *et al*., 2013). It is also more common in populations or age groups that consume raw or undercooked beef. *C. bovis* infection in cattle may not show any clinical disease and therefore goes unnoticed except during abattoir meat inspection. These larvae remain embedded in the tissues of cattle posing serious public health threats. The observations were reinforced by a probabilistic model developed by Kyvsgaard *et al*. (1990) which showed over 85% of infected animals may be missed during routine meat inspection (Worku, 2017). *T. saginata* is the most widely distributed human tapeworm with an estimated 60 million human infection worldwide (Craig *et al*., 2007). Up to 70% of the population in Eastern African countries including Ethiopia were reported to have been infected with *T. saginata* (Kebede *et al.*, 2009)

Hydatid cyst is the metacestode of the tapeworm *Echinococcus granulosus* (*E. granulosus*). Adult worms are found in small intestine of dogs and wild carnivores like wolf and fox. Infested carnivores eliminate eggs with their faeces. Herbivores (intermediate hosts) become infested with the eggs on account of having fed on contaminated pasture. Man is infected incidentally upon ingestion of infective eggs in contaminated water, vegetables and other food or through direct contact with dogs. Consumption of offals containing viable cysts results in infection of definitive hosts (carnivores) including dogs. The most common production practices that increase the prevalence and risk of exposure of domestic animals to cystic echinococcosis are traditional systems of raising animals (extensive or semi-extensive grazing), widespread backyard slaughtering of animals, absence of rigorous meat inspection procedures, improper disposal of dead animals, keeping large number of dogs, failure to treat dogs with anthelmintics, habit of feeding dogs with condemned offals and subsequent contamination of pasture and grazing fields, and grazing of animals in communal fields where stray dogs have free access (Worku, 2017).

Taenia multiceps, predominantly develops in the brain and spinal cord of many mammalian species including human. Coenurosis due to larval stage of *Taenia multiceps* can occur in both an acute and chronic disease forms. Occasionally the signs are more severe and the animal may develop encephalitis, convulse and die within 4-5 days. The infection is acquired in cattle by grazing on pasture contaminated with faeces of humans. Humans become infected after the accidental ingestion of embryonated eggs on fomites or in food and water contaminated by faeces of the infected definitive hosts (Oryan *et al*., 2012).

The prevalence of bovine cysticercosis in Ethiopia reported so far varies from relatively lower prevalence of 3.1% in central Ethiopia (Tembo, 2001) to as high as 26.2% in Hawassa (Abunna *et al.*, 2007) whereas it ranges from 0.007- 6.8% (Dorny *et al.*, 2009) in Europe. Hydatidosis and Coenurosis are much more common in rural areas of Ethiopia where dogs and domestic animals live in a very close association (Fromsa and Jobre, 2011) which is frequently reported from different corners of the country (Biluts *et al*., 2006; Kebede *et al*., 2009a, b, c). Additionally, home slaughtering of cattle, sheep, goats and camels is still predominant and uncooked offal and carcass wastes are normally given for dogs and cats. People in Ethiopia are accustomed to eat raw or undercooked beef dishes such as "***kurt***" and "***kitfo***" (Teka, 1997; Tembo, 2001; Kumar and Tadesse, 2011).

Several studies have been conducted in Ethiopia over the years; however, these studies often had limited scope and coverage. Most slaughtering practices in Ethiopia are often carried out in the field (backyard) in the absence of abattoirs. This allows parasites to continue their life cycle in the years to come. Therefore, avoiding the consumption of raw meat, slaughtering animals on the field and stop free grazing are the preventive measures of cysticercosis (Hailu *et al*., 2019).

Rationale

There is backyard slaughter of cattle for "***kircha***" (traditional ceremony to share beef in and around Debre Berhan town for a team arbitrarily organized into 10-20 people). The offals are given to cats and dogs to be eaten raw. It is customary among the people of Debre Berhan and its surroundings to eat raw beef. Toilets are scarcely available in majority of the houseolds. All these conditions are contaminating the environment and infecting both animals and human beings. There is however lack of recent information on the epidemiology, public health significance, economic loss and public awareness on some major metacestodes in and around Debre Berhan town in particular and North Shoa Zone of Amhara Regional State in general. The size of human population in the zone is increasing from time to time due to urbanization, development of hotel and tourism, industrial development and expansion of higher education. The effects of all these are subsequently increasing the demand for animal products. The implementation of disease control programme is based on a strategic system derived from a sound epidemiological knowledge. Based on this rational thinking, studying the epidemiology of major zoonotic metacestodes of public health and economic importance as well as assessing the public perception towards their zoonotic risk are of paramount importance to design practically acceptable and economically feasible control and prevention methods.

The major objective of the current study was to look into the status and impact of metacestodes in Debre Berhan town with the specific objectives to:

- ✓ Undertake active abattoir survey in order to determine the prevalence of studied zoonotic tapeworms, their distribution in different organs and characterize their cysts,
- ✓ Identify the risk factors facilitated the occurrence of zoonotic tapeworms in cattle, sheep and goats,
- ✓ Undertake retrospective abattoir recorded data analysis to determine the economic losses due to studied zoonotic tapeworms, and
- ✓ Assess the level of community awareness and percentpion towards zoonotic tapeworms.

2. LITERATURE REVIEW

2.1.Definition and Aetiology

Several cestode species affect ruminants in Ethiopia. However, they are seldom diagnosed as a cause of clinical diseases although metacestodes of different cestode parasites of carnivores have been recognized as major causes of ill health in humans and economic losses from organ condemnation during slaughter. Cestodes or tapeworms are parasitic during larval stage of their lives (Nappi and Vass, 2002).

Cysticercus bovis (formerly known as beef measles) causes small cysts in the muscles of cattle and their presence can lead to all or part of the carcass being condemned. Cattle get *C. bovis* from ingesting foodstuffs contaminated with human excreta containg infective eggs. *Bovine cysticercosis* (primarily found in muscle) is caused by the metacestodes (*cysticerci*) of the human cestodes *Taenia saginata*. Hydatid disease (also known as hydatidosis or echinococcosis) is a potentially serious, sometimes fatal, condition caused by cysts containing the larval stages of *Echinococcus granulosus* (*E. granulosus*) tapeworm (dog tapeworm). Coenurosis is a disease of the central nervous system in sheep caused by *Coenurus cerebralis* which is the larval stage of *Taenia multiceps*. *T. multicepts* is a tapeworm which infests the small intestine of carnivores. *Hydatidosis and coenurosis* of farmed and wild animals are caused by the larval stages (metacestodes) of cestodes of the family Taeniidae (tapeworms), the adult stages of which occur in the intestine of dogs or wild Canidae. Cerebral coenurosis (gid or sturdy) particularly affects sheep and goats (Worku, 2017).

2.2.Morphology

Cestodes, or tapeworms, are a class of worms characterized by their flat and segmented bodies. The segments are called proglottides which hold both male and female reproductive organs that allow self-fertilization. Proglottides that contain fertilized eggs break off or dissolve, passing the eggs out of the host. Adult tapeworms typically reside in the intestinal tract of vertebrates, attaching themselves to the mucosal lining with hooks or suckers on their scolex or head. With few exceptions, adult cestodes possess an elongated tape-like body and they do not possess a digestive tract or alimentary canal of their own which differentiated them from trematodes and nematodes, but absorb nutrients through their tegument, or skin, from partially digested food as it passes through the host (Soulsby, 1982).

The habitat of the adult tapeworm is typically the intestinal tract of its host. Cestode larvae, however, invade a wide range of host tissues although most larvae demonstrate a preference for particular, species-specific, sites. The body of a tapeworm consists of an anterior attachment organ or scolex, followed by an unsegmented neck, succeeded by a chain of proglottids ("segments") termed the strobila. The number of proglottids may vary from 3 to 4 in the hydatid worm (*Echinococcus granulosis*), to more than four thousand in the broad or fish tapeworm (*Diphyllobothrium latum*). The scolex may be equipped with various holdfast organs which secure the worm to the mucosa of the host's small intestine. With the exception of the broad tapeworm, which possesses bothria, all tapeworms of humans have four cup-shaped suckers on the scolex. In addition to suckers, most tapeworms have keratinaceous hooks that anchor the scolex to the intestinal wall. In acetabulate cestodes, the hooks may be arranged circularly on a protrusible cone-like structure, the rostellum. In some cases, the rostellum lacks hooks, and is termed "unarmed". In many cestodes, the strobila grows continuously throughout the life of the worm by asexual budding (strobilization) of new proglottids in the neck region (Nappi and Vass, 2002).

Each proglottid moves posteriorly as a new one is formed. As new proglottids are added, the strobila elongates so that in some species enormous lengths are attained. As the proglottids move from the neck region, the reproductive organs mature and the eggs are fertilized. The most recently formed and immature proglottids are found nearest the scolex, while the larger, mature proglottids are found near the middle of the strobila. The terminal portion of the strobila contains ripe or gravid proglottids filled with eggs. Typically, each proglottid contains one or more sets of reproductive organs. Mature segments contain both male and female reproductive organs and thus are capable of self fertilization. Cross fertilization is also possible between different segments of a single worm, or between segments of two worms living together within the host. Usually the male organs mature first and produce sperm that are stored until eggs are manufactured. In some species, the ovary matures before the testes (Nappi and Vass, 2002).

Cysticercus bovis usually occurs in the striated muscles of cattle (beef measles), but also buffalo and various *Cervidae*. Viable cysts are oval, fluid-filled, about 0.5–1× 0.5cm, translucent and contain a single white scolex that is morphologically similar to the scolex of the future adult tapeworm. They are contained in a thin, host-produced fibrous capsule. Cysts occasionally are found in the liver, lung, kidney, fat and elsewhere (Soulsby, 1982).

The morphological feature of adult *Echinococcus* is only a few millimeters long (rarely more than 10mm) and usually has no more than six segments. Anteriorly, an adult *Echinococcus* possesses a specialized attachment organ. The scolex has four muscular suckers with two rows of hooks (one large and one small). The body or strobila is segmented and consists of reproductive units (proglotids) which may vary in number from 2-6. The gravid proglottid, containing several hundred eggs, detaches from the strobila. Each egg contains an embryo (oncosphere) with six hooks (hexacanth). The metacestode stage of *E. granulosus* is hydatid cyst which measures approximately 1cm and it is apparent that its wall consists of two layers, namely an external, cuticular or laminar layer formed by numerous thin nacreous lamina that resemble the cross-section of an onion, and another, internal layer, germinative or proligerous, which is a delicate cellular syncytium. The larval form of *E. granulosus* typically consists of a single cavity (is unilocular). The interior of the hydatid is filled with liquid (Soulsby *et al*., 1982).

The adults of *Taenia multiceps* are up to a meter long in the intestine of canids, have an armed rostellum. *Coenurus cerebralis* are large, white fluid-filled cysts that may have up to several hundred scoleces invaginated on the wall in clusters. Coenuri grow to 5cm or more in size in the brain of sheep, the brain and intermuscular tissues of goats, and also the brain of cattle, wild ruminants and occasionally humans. The cysts induce neurological signs that in sheep are called **'gid'** / **'sturdy'** (Worku, 2017).

2.3.Epidemiology

Livestock may act as the intermediate hosts for the tapeworms of humans and other animals. The larval tapeworms (metacestodes) develop as fluid-hlled cysts, each at a typical site in the body. They act as space-occupying lesions and cause condemnation at meat inspection (Radostits *et al*., 2007).

2.3.1. Agent

Cattle around the world may harbour the metacestode of *Taenia saginata* (the beef tapeworm of humans), also known as *Cysticercus bovis*, in their striated musculature. *T. solium* (the pork tapeworm of humans) occurs similarly in pigs (known as *C. cellulosae*), mainly in poorer regions. The recently discovered *T. asiatica,* found only in East Asia, is closely related to *T. saginata* but uses pigs as its intermediate host. Cysts in the musculature of sheep (known as *C. ovis*) are the intermediate form of a dog cestode (*T. ovis*). Hydatid cysts (*Echinococcus granulosus*), which develop in the lungs and/or liver of sheep, cattle and horses are also acquired from tapeworm eggs excreted by infected dogs and wild canids. These metacestodes rarely cause clinical disease in veterinary species (although some are serious zoonoses). Clinical disease is, however, associated with two other metacestodes. That of Taenia (*Multiceps*) *multiceps* causes coenurosis (**'gid'**) in sheep which affects the nervous system. *Taenia hydatigena* metacestodes are normally asymptomatic but if a sheep or goat swallows a whole tapeworm segment, which may contain 100,000 eggs, sudden death may occur as massive numbers of developing metacestodes (known as cysticerci) migrate through the liver parenchyma. This condition (hepatic cysticercosis) resembles acute hepatic fasciolosis but it is an individual rather than a flock problem (Radostits *et al*., 2007).

Hydatidosis and *Echinococosis* are terms often used interchangeably to describe the zoonotic infection caused by a cestode of genus *Echinococcus* with species *Echinococcus granulosus (E. granulosus)*. *Echinococosis* has a worldwide distribution; the reason is mainly due to ability of this tapeworm to adapt to a wide variety of domestic and wild intermediate hosts. A wide variety of animal species, both domestic and wild, that act as intermediate hosts have made *E. granulosus* to be widely distributed across the globe. The outcome of infection in humans and animals is the development of hydatid cysts in lung, liver or other organs. Hydatidosis due to hydatid cyst is rare in domestic animals, but it is more dangerous in human being. Domestic animals are the main reservoir of infection for man. As the cysts gradually increase in size, they may impair the health status of the host and causes dyspnea when they occur in the lung or digestive disturbance and possible ascites when the liver is affected. Hydatidosis is one of the major causes of organ condemnation and leads to huge economic losses in most Ethiopian abattoirs and slaughterhouses. Human cases of hydatidosis were frequently reported from different parts of Ethiopia. Many potential risk factors might influence the prevalence of bovine hydatidosis and play a role in transmission of the disease. The presence of large stray dog population is thought to contribute significantly to the prevalence of the disease (Akeberegn *et al*., 2017).

Coenurosis is a debilitating disease caused by the larval stage of *Taenia multiceps*. The larval stage of *T. multiceps* appears in two cerebral and non-cerebral forms known as *Coenurus cerebralis* and *Coenurus gaigeri*, respectively (Amrabadi *et al*., 2015).

2.3.2. Hosts

The hosts of *T. saginata* are ruminants namely cattle, sheep, goats, antelops, gazelles, and buffaloes but *Cysticercus* development is unlikely in all these species except cattle. Cattle are the preferred intermediate hosts and humans are the only final hosts of *T. saginata.* Cattle of all ages are susceptible; however young age groups are more susceptible. Man cannot spread taeniasis to his own species. Management of animals in their natural environment predisposes them to infection. Cattle grazing communally (pasture land) in extensive management system have a higher risk of picking up *T. saginata* eggs since they are frequently in contact with human faeces compared to commercial herds. There is no toilet for human use in developing countries and people drop their excreta on pasture lands which increases the risk of cattle infection through ingestion of infective eggs with pasture. Calves are infected usually in early life, often within the first few days after birth from infected stockmen whose hands are contaminated with Taenia eggs (Workus, 2017).

Herbivores such as cattle, goats and sheep are the intermediate hosts that contract hydatidosis by grazing on pastures contaminated with faeces from a dog (definitive host). The dog faeces contain eggs of the cestode. Those eggs are deposited directly on the grazing land or are carried by rain or wind. The dogs in turn are infected by eating viscera that contain fertile cysts (with viable protoscolices). Man is an intermediate host and plays no role in the transmission of the parasite, unless he is eaten by a carnivore. Nevertheless, his sanitary habits make him the main agent responsible for perpetuating the infection by feeding viscera that contain hydatid cysts to dogs (Worku, 2017).

The intermediate hosts of *Taenia multiceps* are sheep and goats and the definitive host is a dog (Shiferaw *et al*., 2016). The transmission cycle of infection by *T. multiceps* takes place between dogs and domestic herbivores. The main factor in maintaining parasitosis in nature is access by dogs to the brains of dead or slaughtered domestic herbivores that were infected with *coenuri*. Man is an accidental host and does not play any role in the epidemiology of the disease (Worku, 2017).

2.3.3. Environment

The complete life cycle of cestodes are mostly influenced by climatic conditions such as optimum humidity (moisture), temperature and rainfall. Moreover, the interactions of canids and herbivores within the same environment create conducive conditions for transmission, survival and multiplaction of cestodes (Soulsby *et al*., 1982). Cool and wet climate may favor the survival of parasite eggs and larvae in the environment and the possible infection of cattle, sheep and goat during feeding. Similarly, higher prevalence in ruminants has been reported in temperate regions (Evalyne and Wyckliff, 2019).

2.4.Life Cycle

The life cycles of all species of *Taenia* are similar. The anoplocephalid tapeworms are very similar. Eggs, which are immediately infective, pass in the faeces of the host, either singly or protected within a tapeworm segment. These are ingested by free-living pasture (oribatid) mites and the intermediate stage (the metacestode) forms. Mature tapewonns develop when the primary host accidentally swallows infected mites while grazing. Most species establish in the small intestine, but *T. actinioides* also invades biliary and pancreatic ducts, while *A. perfoliata* is found around the ileocecal junction and *S. hepatica* lives in the bile ducts. Lengths vary with species: *A. perfoliata* grows to 4-8 cm while *Moniezia* may be over 2 m (Radostits *et al*., 2007).

The adult tapeworm lives in the small intestine of its definitive host. Proglottids, which contain eggs, break off the posterior end of the tapeworm, and these proglottids are either passed intact in the host's faeces or they dissolve in the host's intestine and eggs are passed in the faeces. When a suitable intermediate host ingests the eggs, the oncosphere larva is released and, with the aid of the embryonic hooks, penetrates the intestinal wall and enters the bloodstream. Upon reaching the liver the oncosphere begins to develop into a *cysticercus* (bladder worm). Bladder worms break out of the liver and attach to the mesenteries throughout the abdominal cavity. The definitive host is infected when it eats an intermediate host infected with *cysticerci*. Upon ingestion, the scolex evaginates, attaches to the intestinal lining, the bladder disintegrates, and the strobila is formed by the budding of the neck region (Worku, 2017).

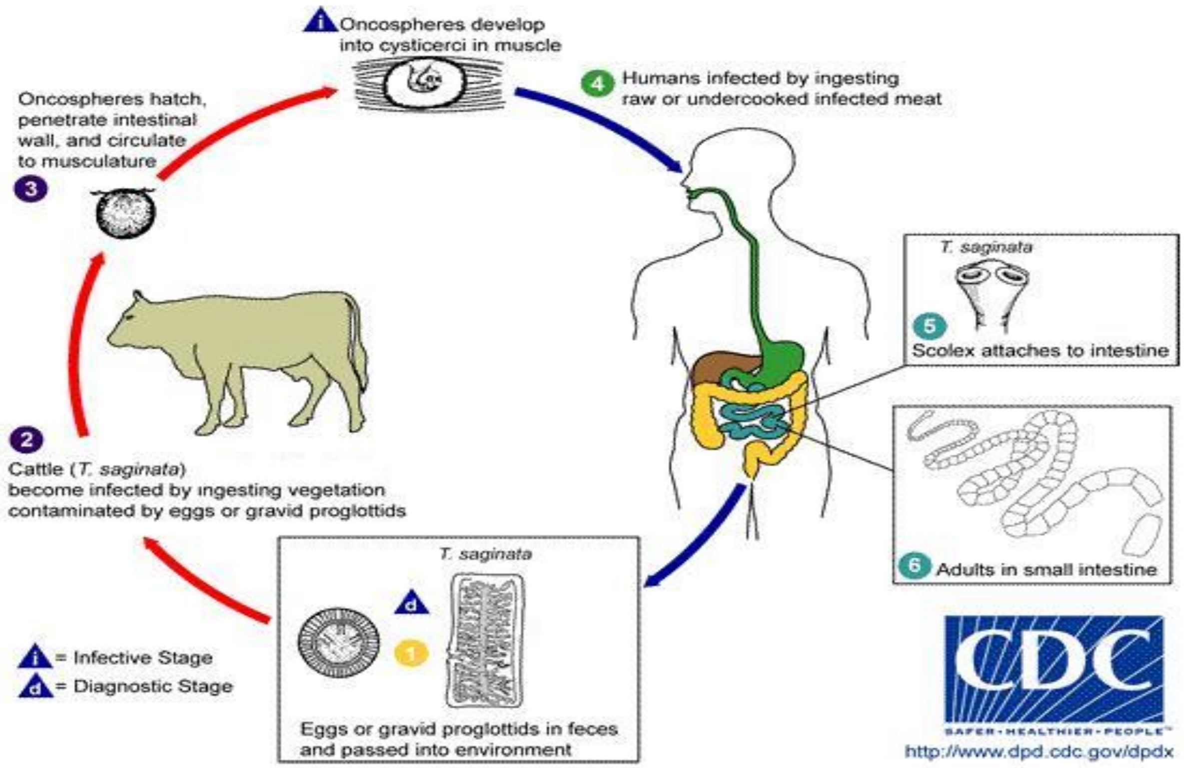

Figure 1. Life cycle of *Taenia saginata*

Source: (http://www.dpd.cdc.gov/dpdx)

Echinococcus species have an indirect life cycle which develops in both an intermediate and the definitive hosts. The parasite cycles in many cases through the specific predators, scavengers and its preys. The dog-sheep cycle is most likely to result in human infections. Other cycles include dog-camel, dog-horse, wolf-deer and coyote-deer.The definitive hosts are carnivores which harbor mature tapeworm in their intestine and excrete the parasite eggs along with their faeces and play a major role in the epidemiology of the disease while livestock /cattle/ and humans are intermediate hosts which are infected by ingestion of eggs within the faeces of the definitive host. Parasites can develop in a variety of organs in the intermediate hosts but are often found in the liver and lungs. Larval/hydatid cyst/ stage from the embryo released from an egg develop a hydatid cyst, which grows to about 5–10cm within the first year and is able to survive within organs for years. The transmission of *Echinococcus* species from intermediate to definitive host is the result of predator pre-relationship existing between hosts; however, it can be modified by human behavioral factors for synathropic cycles and man is usually a dead end intermediate host (Akeberegn *et al*., 2017; Worku, 2017).

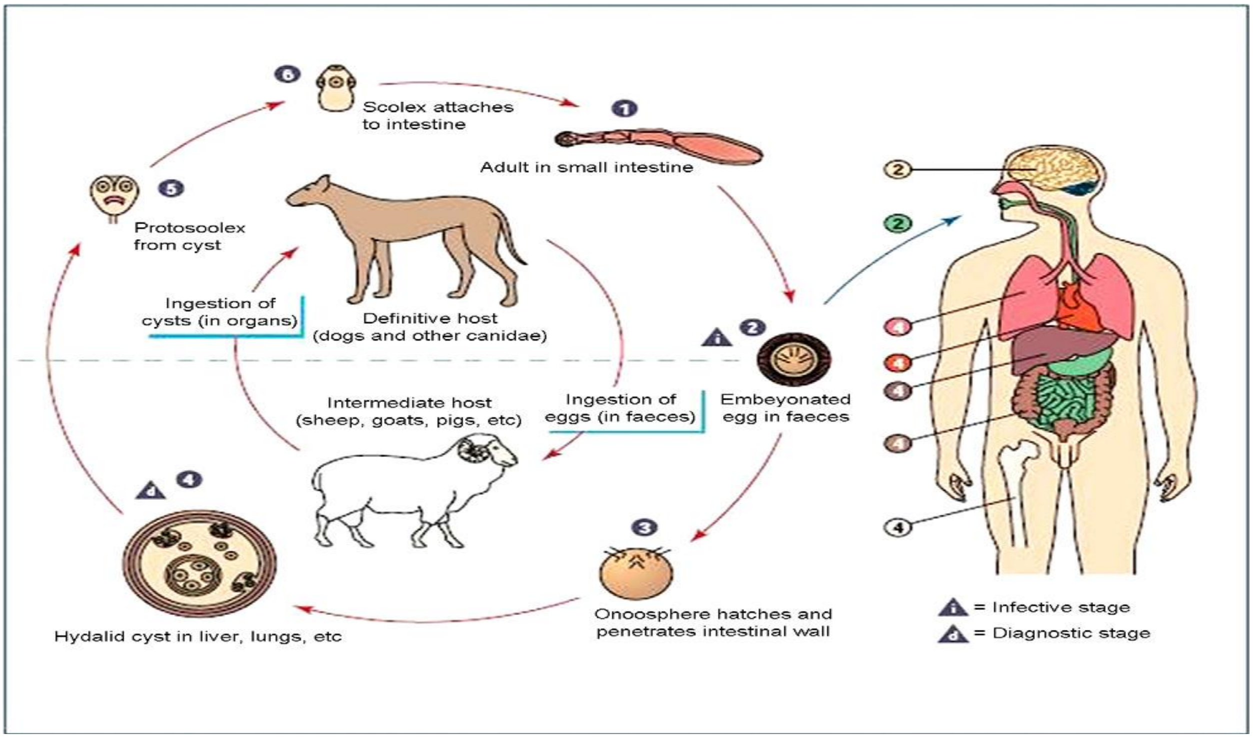

Figure 2. Life cycle of *Echinococcus granulosus*

Source: (http://www.dpd.cdc.gov/dpdx/html/Echinococcosis.htm**)**

The life cycle of *T. multiceps* is indirect with sheep and goats acting as an intermediate host. Coenurosis results from ingestion of contaminated pasture with eggs. After ingestion of the eggs, the gastric and intestinal juices digest the embryo and the onchosphere is activated. After penetrating the gastric and intestinal mucosa, it passes into the blood and lymphatic circulation. Only those which reach the central nervous system (CNS) develop to form metacestodes in 2-8 months and induce nervous symptoms and death. The rest, which reach other tissues, will die. The onchosphere of *Taenia multiceps* has a specific affinity for nervous tissue and eventually lodges in two predilection sites (brain or spinal cord). Cerebrospinal fluid (CSF) is required for species differentiation, nourishment and growth of the metacestode. The scolices develop from the base of the invaginated outer surface of the wall of a metacestode. *Taenia multiceps* reach maturity after 40-42 days in the small intestine of the final host. After the prepatent period, the dog starts to disseminate 3-4 proglottids daily which contain approximately 37,000 eggs each. The eggs of *T. multiceps* are usually released from the proglottids before they are voided in the faeces. Eggs contaminate the environment and waters and resist for 15 days under dry conditions or 30 days with high level of humidity. At high temperatures, they died in a few hours. After ingested by ruminants, the onconspheres in the small intestine spread from eggs to reach various locations through blood circulation. However, it is only in the CNS that they could develop into mature *Coenurus* cysts. The cyst takes approximately 8 months to mature during which it becomes progressively larger as the volume of the fluid increases. At maturity, it can reach a diameter of 5cm or more in which it will result in the onset of clinical signs due to increased intracranial pressure and causes deviation of the head, headache, stumbling and paralysis. Again when this mature cyst is eaten by a definitive host, scolex exvaginate and attached to small intestinal wall of a definitive host that turn into adult parasite and the cycle continues (Shiferaw *et al*., 2016).

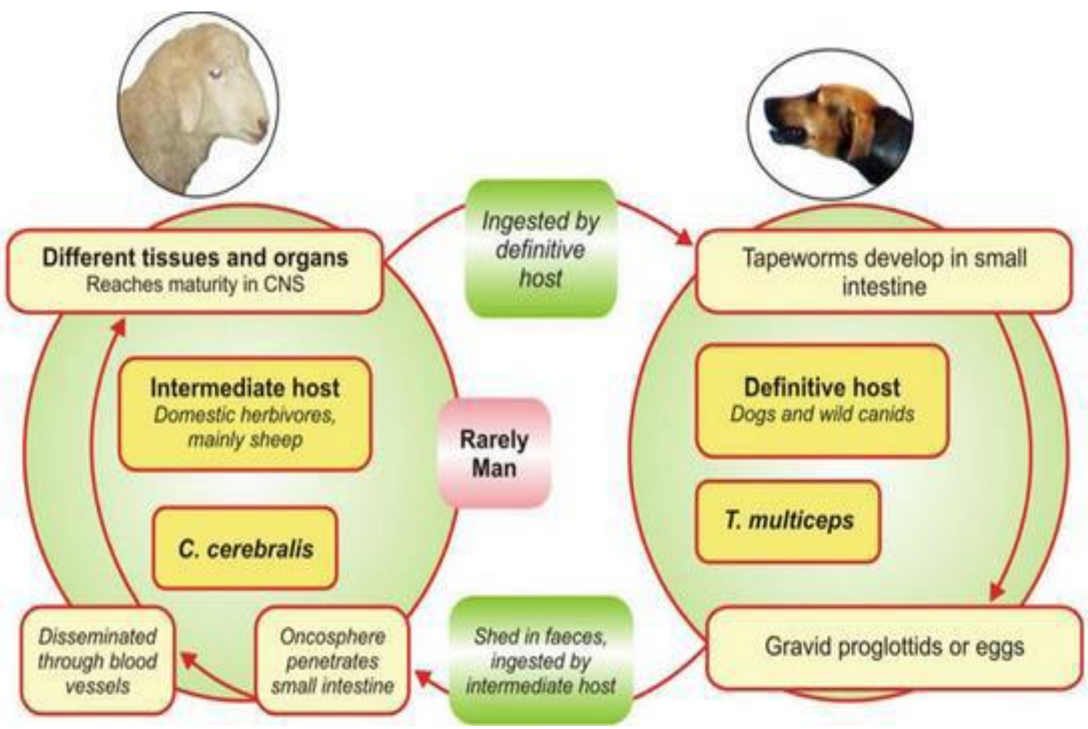

Figure 3. Life cycle of *Coenurus cerebralis*

Source: (Shiferaw *et al*., 2016)

2.5.Pathogenesis

Anoplocephalid tapeworms have little apparent effect on the health of ruminants in heavy infestations. It has been postulated that they may compete for nutrients, excrete toxic materials or because of their length they interfere with motility of the gut. Very heavy burdens have been associated with enterotoxemia. Pancreatic and biliary duct species cause little harm but liver damage may cause rejection at meat inspection. The ileocecal valve may be thickened. Heavy infestations may interfere with gut motility and increase the risk of ileocecal colic. A recent matched case-control study indicated that 22% of a series of spasmodic colic cases were likely to have been tapeworm associated (Urquhart *et al*., 1996; Radostits *et al*., 2007).

2.6.Clinical Findings

There is disagreement over the importance of anoplocephalid tapeworms in causing disease in ruminants. Farmers usually overemphasize their importance while veterinarians underestimate it. Most infestations are asymptomatic but, on occasion, heavy burdens may result in unthriftiness, poor coat, vague digestive disturbances including constipation, mild diarrhea and dysentery, and sometimes anemia. These signs are restricted chiefly to animals less than 6 months of age on an inadequate diet. Signs may be delayed until the animal reaches a later age. Infested animals may be more susceptible to the effects of other internal parasites and to other diseases or adverse environmental conditions (Soulsby, 1982; Radostits *et al*., 2007).

2.7.Clinical Pathology

Shed tapeworm segments may be visible macroscopically on the skin and hair around the tail base or in the faeces. Eggs may be present in faeces (Urquhart *et al*., 1996; Radostits *et al*., 2007).

2.8.Necropsy Findings

The site of attachment on the intestinal mucosa may be indicated by the presence of a small ulcer and a mild inflammatory response (Radostits *et al*., 2007).

2.9.Diagnostic Confirmation

The metacestodes are readily visible in the organs or musculature at autopsy and therefore; diagnosis of *C. bovis*, hydatid cyst and *C.cerebralis* is usually made during postmortem examination in abattoirs and packing plants. In canids, *Echinococcus* spp. eggs cannot be distinguished from *Taenia* spp. eggs, but the presence of the former can be determined by tapeworm size and *Echinococcus* specific antigen-capture enzyme linked immune-sorbent assay (Ag-ELISA) (Worku, 2017).

Shed segments are much wider than they are long. They can be seen to be full of characteristic eggs if broken in a drop of water on a slide and examined microscopically. AnoplocephaIid eggs are roughly D-shaped, thick-shelled and contain an embryo within a chitinous ring. They are not easy to find in faeces. Centrifugation/ flotation using a saturated sugar solution are recommended for diagnosis in horses. At best the sensitivity of such techniques is only 60% for light infections and rising to 90% for heavy burdens. So, repeated samples may be needed to demonstrate the presence of the parasite. Alternative methods have been devised for detection of specific antibodies in the serum or antigen in faeces but are not as yet generally available (Radostits *et al*., 2007). The routine stool examination technique employed by Debre Berhan Referral Hospital Parasitology laboratory was formalin ethyl acetate (formol-ether) concentration technique (Yimer and Gebrermedhin, 2019).

2.10. Treatment

For ruminants, praziquantel 3.75 mg/kg is highly effective against *Moniezia* but higher doses are required for *Thysaniezia* spp. (5 mg/kg), *Avitellina* (7.5 mg/kg) and *Stilesia hepatica* (15 mg/kg). Some benzimidazole and pro-benzimidazole drugs have cestocidal activity in ruminants including albendazole, febantel, fenbendazole, mebendazole, netobimin and oxfendazole. The efficacy of some of these compounds against *Moniezia* may be variable. Albendazole at 7.5 mg/kg is effective against cestodes in the bile ducts (Radostits *et al*., 2007; Work, 2017). Treatment also consists of refrigeration (carcass moved to a freezer at 15°F and kept there for a minimum of ten days) or heating (carcass is heated throughout to a minimum internal temperature of 140°F) (Kassai, 1999). In humans Niclosamide is effective at dose rate of 2000 mg and it damages the worm to such an extent that a purge following therapy often produces the scolex. Praziquantel at a dose rate of 5-10 mg per kg also has been reported highly effective but the scolex is partially digested and often not recovered (Smyth, 1994).

2.11. Control

Measures employed in the control of taeniasis and cysticercosis include diagnosis and treatment of Taenia carriers, education of the mass to use latrines, avoid the consumption of raw meat and postmortem inspection of carcasses for the presence of *C. bovis* (Yimer and Gebrermedhin, 2019). If infection was confirmed, the meat would be destroyed or frozen to inactivate the cysts of *C. bovis* and prevent transmission to people. Do not feed dogs raw offals, correct disposal of sheep and goat brain after slaughtering or death of animals to prevent scavenging by dogs and regular anthelmintic treatment of dogs at 6-8 week intervals (Worku, 2017).

2.12. Economic Importance

Taeniasis in ruminants results in an enormous economic damage due to condemnation of affected organs and declining of meat, milk and wool production. The adult tapeworm is comparatively harmless to the dog but its larval stage is a disease of immense medical and economic importance. In severe infection, the parasite may cause retarded growth, reduced performance and reduced quality and yield of meat and milk. Additionally, fertility and the value of fleece are reduced due to infection. Condemned organs or even the whole carcass represent a high financial loss in many countries. The importance of these losses depends largely on the characteristics of the farming or livestock industry in a particular country (Polydorous, 1981; Tadesse *et al*., 2016).

2.13. Public Health Importnace

Tapeworms of the family Taeniidae are transmitted from the definitive hosts such as carnivores to the intermediate hosts including herbivores or omnivores and human beings via oral-fecal cycle. Humans acquire infection by inadvertent consumption of ova or larval stages/viable cysticerci (metacestode) present in raw or undercooked meat. *Cysticerus bovis*, the metacestode of *T. saginata*, occurs only in beef and humans act as the natural final host of these tapeworms. This family includes two major genera namely *Taenia* and *Echinococcus*. The Taenia species include *T. saginata*, *T. solium, T. asiatica*, *T. hydatigena*, *T. ovis*, *T. multiceps, T. serialis, T. pisiformis, T. taeniaeformis*, and *T. crassiceps*. All these species except for *T. hydatigena* (*C. tenuicollis*), *T. ovis* (*Cysticercus ovis*) and *T. pisiformis* (*C. pisiformis*) cause zoonotic parasitic diseases and thereby are of public health importance (Worku, 2017).

Taeniasis is the intestinal infection of humans by the adult stage of cestodes of the genus *Taenia*. The principal cestodes which are important to cause taeniasis in human are *T. saginata, T. asiatica, T. solium* and *Diphllobothrium latum*. These parasites use intermediate hosts such as cattle, swine and fish, respectively. Many parasites infect an intermediate host organism while in a developmental form, but they do not grow to maturity until they have been transmitted to the final or definitive host. They develop into an intermediate stage called *Cysticercus* that embeds in the muscle and connective tissue of the animal. The primary risk factor that sustains the transmission of the disease is being unsanitary disposal of human faeces and eating raw or insufficiently cooked beef or pork or fish. Adult *T. saginata* resides in the small intestine of infected human. *T. saginata* is considered to be distributed worldwide. It is highly prevalent in developing countries especially in Africa, Latin America, Caucasians, Asia and eastern Mediterranean countries. Indiscriminate defecation due to lack of latrine facilities is the commonest practice experienced by 85% of the rural community in Ethiopia (Worku, 2017; Yimer and Gebrermedhin, 2019).

The diseases caused by the genus *Taenia* in humans, in many endemic areas, are often categorised as neglected tropical diseases. The larval stages or metacestodes in general belong to these tapeworms include hydatid cyts, cysticerci and coenuri. The cysticerci of *T. solium* can themselves cause medical complications. Instead of developing immediately into adult tapeworms, these cysticerci can migrate to any organ of the body, commonly ending up in the muscles or brain. A serious infection in the brain can lead to mental complications including seizures and personality changes (Soulsby, 1982).

The prevalence of *T. saginata* infection in human was not significantly decreased year after year in the population. Therefore, proper treatment of infected people as well as continuous public education should be provided to avoid consumption of raw meat and improving sanitary conditions by using latrine. Public education reduces the public health risk and economic impact of *T.saginata* / *C. bovis* in Debre Berhan town (Yimer and Gebrermedhin, 2019).

Neurocysticercosis is regarded as the most common zoonotic parasitic disease of the central nervous system (CNS) caused by *T. solium*. The metacestode called *C. cellulosae* affects human beings as the definitive and it is also an aberrant host. Indeed, human acquire this metacestode via ingestion of undercooked pork infected with cysticerci. On the other hand, the eggs hatched in the human intestine can finally produce the cysts in areas with high blood flow such as CNS (neurocysticercosis), the muscles (human cysticercosis), the subcutaneous tissue and the eye (subcutaneous and ocular cysticercosis, respectively). *T. asiatica*, also known as Asian Taenia, is similar to *T. saginata* which is responsible for intestinal teniasis and has been identified in several Asian countries. *C. fasciolaris* is the larval stage of the cestode *T. taeniaeformis* occurring in wide variety of small rodents and occasionally birds and humans as intermediate hosts but cats as the definitive hosts. Adult forms of *T. taeniaeformis* and *C. fasciolaris* have been recognized in the intestine and liver of humans, respectively. Nonetheless, it seems that these cestodes are associated with low health risk to humans (Worku, 2017).

Hydatid disease or cystic echinococcosis (CE) is caused by the larval stage of *E. granulosus* associated with the existence of cysts in visceral organs especially the liver and the lungs. This cestode with its metacestode is recognized as the most important helminthic zoonoses and is of great public health and economic importance especially in tropical and developing countries. Alveolar echinococcosis, a parasitic disease with public health importance, is caused by the cestode *E. multilocularis* transmitted between intermediate hosts such as rodents and definitive hosts including wild carnivores especially foxes. In humans, the metacestodes proliferate and form tumor-like masses causing organ dysfunction. The disease, if remains untreated, can lead to death of the patient due to unlimited proliferation and metastasis of the lesions. Polycystic echinococcosis caused by the metacestodes of *E. vogeli* and *E. oligarthus* is regarded as an emerging parasitic zoonotic disease with public health concern in the humid tropical rainforests. The intermediate hosts for *E. oligarthus* include wild rodents with the development of cysts in muscles, subcutaneous tissues or lungs, liver and spleen. In human cases, they have been found in the heart muscle, behind the eyes and the liver (Urquhart *et al*., 1996). The annual surgical cases of human CE in Iran are reported to be 1–2 per 100,000 people and the sero-prevalence of the disease is 3–19% in different areas of the country. Of course, CE is a notifiable disease in Iran (Ahmadi and Meshkehkar, 2011).

Coenurosis occurs in cerebral and non-cerebral forms. The former is caused by the larval stage of *T. multiceps* which possesses a metacestode stage called *Coenurus cerebralis*. *T. gaigeri* with its metacestode termed *C. gaigeri* causes non-cerebral coenurosis with cysts in the muscles of the intermediate hosts including herbivores as well as humans. It is unclear and debatable that *C. cerebralis* and *C. gaigeri* are the same or different species and the researches are focusing and performing detailed studies to answer this question. *Coenurus serialis*, the larval stage of the cestode *T. serialis* are found as fluid-filled cystic masses in the muscles and subcutis of rodents and rarely humans as the intermediate hosts. This cestode is similar in many characteristics to *T. multiceps*. *T. crassiceps* is intestinal tapeworm of carnivores forming the cyst-like larvae or metacestodes (cysticerci) in the body cavities and subcutaneous tissues of rodents as the intermediate hosts. The muscles and subcutis of the immunosuppressed humans and the eye and cerebellum in immunocompetent ones are involved by the cestode larvae as tumor-like masses (Urquhart *et al*., 1996).

In conclusion, different scholars confirmed the endemic occurrence of Taeniasis, Hydatidosis and Coenurosis in and around Debre Berhan town. Diagnostic methods mostly include serologic tests such as ELISA, imaging and scanning techniques like magnetic resonance imaging (MRI), computed tomography (CT) and ultrasound. It is mandatory to control Tapeworms given their high public health significance. An effective preventive programme and also early diagnosis should be designed and implemented. An appropriate treatment is necessary. Development of an effective, safe and cheap vaccine against parasites can be helpful. On the other hand, close proximity of the final hosts such as dogs to humans in these cases may be a main factor in the occurrence of human cases of the disease. Therefore, dogs should be considered as the main source of infection and the major risk factor. The major problem for control of these diseases is reducing the risk factors including access of the stray dogs and other wild carnivores to infected carcass wastes, consumption of raw meat and unwashed vegetables, poor sanitation, use of human faeces as fertilizer and inadequate meat inspection. Regular deworming and repeated treatment of dogs, the major final host in most cases, with anti-parasitic agents is helpful to break the life cycle of these parasites. Public awareness creation on different ways of parasite transmission, accuracy in carcass inspection, health education for dog owners, proper condemnation of infected carcass and offals to reduce the stray dog population which all can be useful in reducing the prevalence and incidence of these zoonotic parasitic diseases (Urquhart *et al*., 1996).

3. MATERIALS AND METHODS

3.1.Study Area

The present study was conducted from November 2019 to April 2020 at Debre Berhan municipality abattoir which is located in Debre Berhan town. Debre Berhan town is one of the ancient great Ethiopian towns founded by Emperor Atse Zara Yaqob in 1456 at central Ethiopia and situated at 130 km in Northeast direction to Addis Ababa, the capital of Ethiopia. The area is founded at an altitude of 2780 meters above sea level. Debre Berhan is located at a grid reference point of 09^{0}01'232" north latitude and 038^{0}48'177" east longitude. The climatic condition of the area is 50% highland, 46% midland, 2% lowland and 2% wurch. It has an annual rainfall and temperature ranging from 814-1080mm and $10\text{-}20^{0}$C, respectively. The rainfall is bimodal in distribution with the short rainy season (*belg*) extending from February to May and long rainy season (*meher*) from June to the beginning of September (Debre Berhan town office of Agriculture, 2019).

Agriculture is the main stay of the people in the area. The agricultural activities are mainly mixed type characterized by livestock rearing and crop production. Intensive and semi-intensive livestock management system is the predominant husbandry practices in the area. Crop residues and natural grazing land are the major livestock feed resources. Fallow land, crop aftermath and concentrates are occasionally available feed resources. The livestock species reared include indigenous zebu cattle (*Bos indicus*) and their crosses with exotic breed (*Bos taurus*) of temperate origin, sheep (*Ovis aries*) and goats (*Capra hircus*). The estimated annual animal population slaughtered at Debre Berhan town is 7500 small and large ruminants (Debre Berhan town office of Agriculture, 2019).

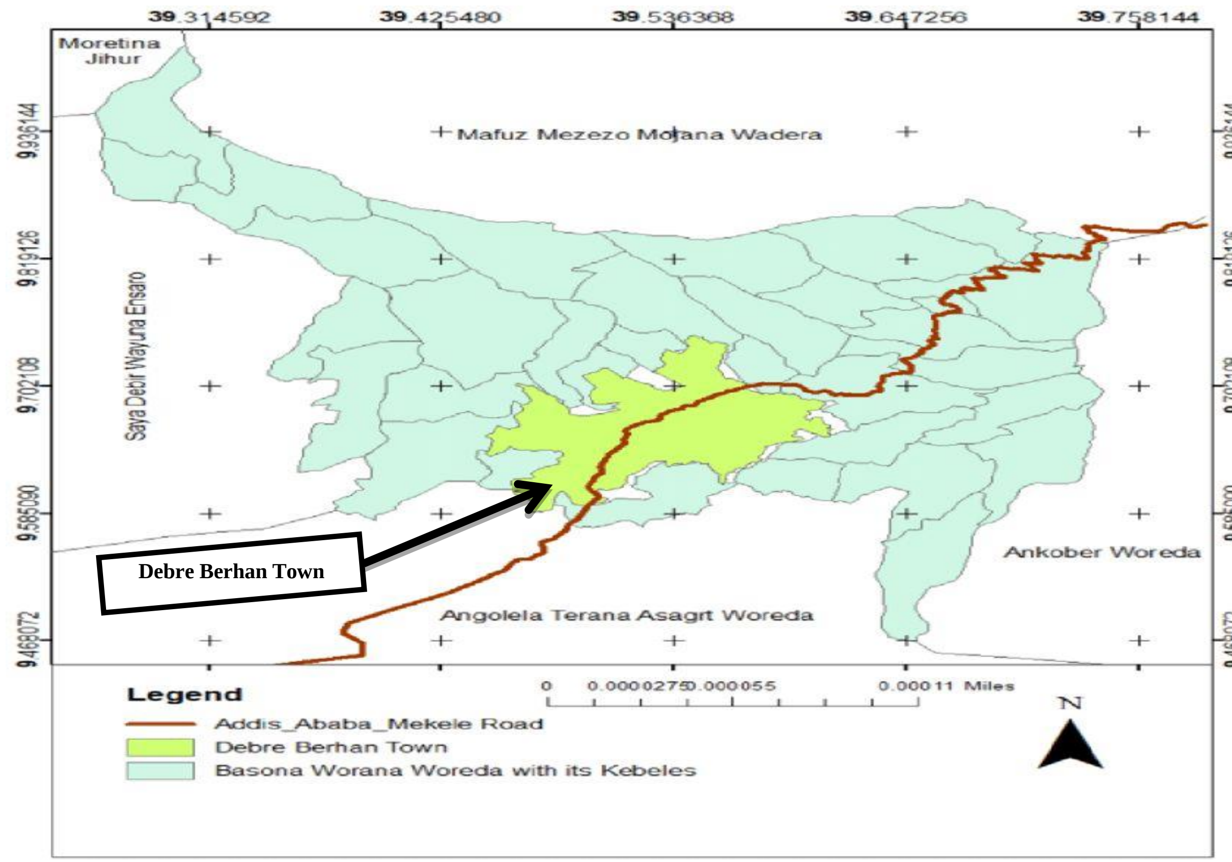

Figure 4. Map of Debre Berhan town

Source: Debre Berhan town office of Agriculture (2019)

3.2.Study Animals and Sampling

Cattle, sheep and goats from Debre Berhan and surrounding *Woredas* (Woreda means District in English) are the major sources of animals for slaughter at Debre Berhan municipality abattoir. The geographical origin of the animals slaughtered at this abattoir is from different areas and the majority of them are coming from the nearby markets such as jiru, Ankober, Kotu, Sheno but they may come from Addis Ababa which is transact from other areas. Hence, it may be difficult to relate the findings with the prevalence to metacestodes to a particular agro-ecology. The abattoir servey were conducted two days per week (days of larger number of animals slaughtered were selected) and on the study day; daily based systematic random sampling was made among animals coming to the abattoir. The variables (potential risk factors) of interest were breeds (local and cross), species, sex, age, body conditions and seasons of the year (dry and wet seasons). The age of cattle was determined based on the dentition formula adopted by

Mississippi State University (2013). Similarly, the ages of goats and sheep were determined based on the dentition formula adopted by Girma and Alemu (2008). Moreover, the body conditions of cattle were assessed based on the criteria developed by Nicholson and Butterworth (1986). Emaciated animals that were unfit for slaughter were excluded from slaughter. The average number of cattle slaughtered each day ranged from 25-35 heads. The body conditions of sheep and goats were assessed based on the criteria used by Girma and Alemu (2008).

3.3.Study Design and Sample Size

A cross-sectional study design was employed to conduct a study on the occurrence of cestodes in ruminants slaughtered at Debre Berhan municipality abattoir. By rule of thumb where there is no information for an area about a certain disease then it is possible to take 50% expected prevalences. To calculate the sample size, 5% desired absolute precision and 95% confidence interval were considered. The sample size was computed using the following formula adopted by Thrusfield (2007):

$$n = \frac{(1.96)^2 P_{exp} (1-P_{exp})}{d^2}$$

Where,

n= sample size; 1.96 = multiplier of the 95% confidence interval; Pexp = expected prevalence (50%) and d^2 = desired absolute precision (5%)

Substituting the values in the above formula yields the following:

$$n= \frac{(1.96)^2 0.5 (1-0.5)}{(0.05)^2} = 384 \text{ (minimum sample size)}$$

In order to maximize the precision of the study the calculated sample size was increased to 768 ruminants. A total of 692 cattle coming to slaughter at Debre Berhan municipality abattoir and 76 sheep and goats from individual butcher shops were selected for active abattoir survey.

The number of participants for questionnaire survey was determined based on the formula recommended by Arsham (2006): $n = 0.25/ SE^2$

Where, n = sample size; SE= standard error (5%) at 95% confidence interval

Substituting the value in the formula yields the following:

$$n = 0.25/(0.05)^2 = 100$$

In total, 100 participants were involved in the questionnaire survey.

3.4.Data Collection and Examination

3.4.1. Active abattoir survey

Active abattoir survey was conducted by employing routine meat inspection procedures (antemortem and postmortem) (FAO, 1994) on 692 heads of cattle slaughtered at Debre Berhan municipality abattoir and 76 sheep and goats slaughtered at individual butcher homes. Animal level variables (risk factors) such as sex, age, breed, body conditions and seasons were recorded during antemortem inspection (AMI) in a format prepared for this purpose. The animals were categorized into poor, medium and good depending on their body condition scores before slaughtering. Identification of animals was done with ID number given to each butcher-rman which was written on the lateral aspect of the back of each animal using an indelible ink. The same ID was transferred to all visceral organs after slaughter. Each organ with its predilection site for metacestodes was carefully inspected for the presence of respective larvae.

Thorough visual inspection, palpation and systematic incision of each visceral organ were carried out during postmortem inspection (PMI). Hydatid cyst was inspected particularly in the liver, lungs, kidneys, heart and spleen.

3.4.2. Assessment of cysticercosis

The predilection site of cysticercosis was assessed as follows. Deep linear incisions were made in masseter muscle parallel to the mandible. The tongue was examined from base to apex. The heart was incised from its base to the apex to open the pericardium and incision was also made in the cardiac muscle for detailed examination. In addition, deep, adjacent and parallel incisions were made above the elbow joint in shoulder, biceps and triceps muscles. Examination of kidneys, liver and lungs were also conducted accordingly.

3.4.3. Cyst collection and characterization

Hydatid cysts were collected from different internal organs during PMI and taken to Veterinary Parasitology Laboratory, Department of Animal Sciences, College of Agriculture and Natural Resource Sciences, Debre Berhan University.

Cyst count, cyst size measurements, fertility and viability tests were conducted in all collected hydatid cysts. The size of hydatid cyst was measured and classified as small if the diameter is less than 4 centimeter, medium if the diameter is between 4 and 8 centimeter and large if the diameter is greater than 8 centimeters (Oostburg *et al.*, 2000).

Each cyst wall was penetrated by a needle and opened with scalpel and blades. Then, the contents were transferred into a sterile test tube. Based on the presence or absence of broad capsule containing protoscolices in the hydatid fluid, cysts were classified as fertile or infertile. The infertile cysts were further classified as sterile (fluid filled cyst without any protoscolices) and calcified. Viability of protoscolices was determined by taking a drop of the sediment consisting of the protoscolices and placing on a microscopic slide. Equal amount of 0.1% aqueous eosin solution was added to the slide and then covered with a cover slip. It was then observed under a microscope (x40). Viable protoscolices should completely or partially exclude the dye while the dead ones take it up (FAO/UNEP/WHO, 1994; Swai and Schoonman, 2012).

The viability of the *C. bovis* was examined by using 30% ox bile solute which diluted in normal saline and incubated at 37 °C for 1:30 hours. A cyst was regarded as viable if the scolex is evaginated according to Gracey (1999).

3.4.4. Retrospective study and estimation of economic losss

Recorded data for the last three and half years (2009- mid-2012 EC) were obtained from Debre Berhan municipality abattoir records. The record was referred for *Cysticercus bovis* and hydatid cysts in relation to breed, sex, age, body condition scores (BCS), years, and organs condemned with causes of condemnation. Moreover, months were grouped into dry and wet seasons based on metereological recorded data for Debre Berhan town in those given years of the current investigation. The economic losses were estimated for each year and for different condemned organs. The prevalence of bovine cysticercosis and hydatidosis was calculated from organs condemned due to cysts to the total number of cattle slaughtered with the given years and expressed in percent.

An attempt was made to estimate the annual economic losses due to *C.bovis* and hydatid cyst in cattle slaughtered at Debre Berhan municipality abattoir by taking into account the direct (cost of offal condemned) and indirect (reduced carcass weight) losses. The retail market price of organs and information on the cost of 1kg of beef were obtained from local butchers. The total number of condemned organs due to bovine cysticercosis and bovine hydatidosis was obtained from Debre Berhan municipality abattoir records. The total number of slaughtered cattle at Debre Berhan municipality abattoir was 26246 over the last three and half years (2009-mid 2012 EC) and estimated 5% carcass weight loss was considered to calculate the indirect loss (Polydorous, 1981). The average carcass weight of Ethiopian local zebu breed cattle is estimated as 126 kg (WHO, 1983). The total economic loss was calculated as the summation of cost of offal condemned plus the cost of carcass weight loss (ILCA, 1993):

1. Total cost of offal condemned = (NLu* CLu) + (NLi * CLi) + (NKid * CKid) + (NHe * CHe) + (NDi * CDi) + (NTo * CTo) + (NHea * CHea)

2. Total cost of carcass weight loss = 5% * CSR * P H* PC * CPB *126kg. Where:

   NLu= Number of lungs condemned

   CLu= Mean cost of one bovine lung in Debre Berhan

   NLi = Number of livers condemned

   CLi = Mean cost of one bovine liver in Debre Berhan

   NKid = Number of kidneys condemned

   CKid = Mean cost of one bovine Kidney in Debre Berhan

   NHe = Number of hearts condemned

   CHe = Mean cost of one bovine heart in Debre Berhan

   NDi = Number of diaphragms condemned

   CDi = Mean cost of one bovine Diaphragm in Debre Berhan

   NTo = Number of tongues condemned

   CTo = Mean cost of one bovine tongue in Debre Berhan

   NHea = Number of heads condemned

CHea = Mean cost of one bovine head in Debre Berhan

CSR= Numbers of cattle slaughtered (from 2009- mid-2012 EC)

PH = Prevalence of bovine hydatidosis in Debre Berhan from the three and half years of abattoir records

PC = Prevalence of bovine cysticercosis in Debre Berhan from the three and half years of abattoir records

CPB = Average market price of one 1kg of beef in Debre Berhan (2009- mid-2012 EC): 5% is considered to estimate carcass weight loss in individual animal due to *C.bovis* and hydatid cyst

3.4.5. Questionnaire survey

The structured questionnaire was pretested and adjusted for clarity before subjected to participants. It was administered in face-to-face modality to know the level of awareness and perception of the community with regard to the occurrence of cysticercosis and hydatidosis in ruminants and human beings. There were 100 volunteer participants in Debre Berhan town. Participants were pre-informed about the objective of the study and gave an informed consent and assent to proceed with the study. They had the liberty to withdraw at any time from the study if they had any sort of discomfort. Socio-demogrpahic data such as age, sex, religion and occupation of participants were identified and recorded in a format prepared for this purpose. Those who had the habit of consuming raw beef were identified and requested to justify their reason of consuming beef in raw form. Less educated group in this study included those who attended informal and elementary education. More educated ones on the other hand are those who attended high school and college level educations.

3.5.Dataset Management and Analysis

Data collected from abattoir and questionnaire were recorded in Microsoft excel spreadsheet, thoroughly screened for errors, coded, imported and analyzed using SPSS.ver.20 statistical software. Descriptive statistics were used to summarize data and see its nature of distribution. Prevalence was calculated based on the number of animals inspected with cysts to the total number examined and expressed in percent. The degree of association of risk factors to the occurrence of metacestodiasis was further analyzed using Chi-square (χ^2) test of independence. The strength of association of independent variables (species, age, sex, breed, body condition and seasons) was determined by odds ratio. The 95% confidence interval (CI) was indicated for each risk factor and $P<0.05$ was set for statistical significance.

4. RESULTS

4.1. Active Abattoir Survey

The overall prevalence of metacestodes of cattle, goats and sheep slaughtered at Debre Berhan municipality abattoir was found to be 10.8% (83/768). The prevalence of metacestodes per species has shown to be 10.4% (72/692) in cattle, 17.9% (5/28) in goats and 12.50% (6/48) in sheep (Table, 1). There was no statistical significant difference in the occurrence of metacestodes among the species of domestic animals examined (P>0.05).

Table 1. The overall prevalence of metacestodes in ruminants

Variables	No. examined	Prevalence (%)	OR	95% CI	$\chi 2$	P-value
Species	**768**	**83(10.8)**	**1.18**		**1.703**	**0.427**
Bovine	692	72 (10.4)	Ref	Ref		
Caprine	28	5 (17.9)	0.813	0.334, 1.979		
Ovine	48	6 (12.5)	1.522	0.418, 5.534		

OR = Odd Ratio

4.2. Assessment of Cysticercosis

The prevalence of *C.bovis* in local zebu cattle was estimated to be 1.3% (9/692). There was no statistical significant association (P>0.05) in prevalence of *C. bovis* and putative host risk factors (sex, breed, season and age of animals slaughtered). On the other hand, the association between the prevalence of *C.bovis* and body condition scores of cattle was statistically significant (P<0.05) (Table 2).

Table 2. Prevalence of *C. bovis* based on different host risk factors

Variables	No. examined	Prevalence (%)	OR	95% CI	χ^2	P –Value
Breed	**692**	**9 (1.3)**			**0.929**	**0.335**
Cross	64	0 (0)	Ref	Ref		
Local	628	9 (1.43)	0.00	0.00		
Sex	**692**	**9 (1.3)**			**1.026**	**0.311**
Female	70	0 (0)	Ref	Ref		
Male	622	9 (1.5)	0.00	0.00		
Age	**692**	**9 (1.3)**			**1.875**	**0.171**
Young	118	0 (0)	Ref	Ref		
Adult	574	9 (1.6)	0.00	0.00		
BCS	**692**	**9 (1.3)**			**12. 695**	**0.002**
Good	136	0 (0)	Ref	Ref		
Medium	486	5 (1.0)	0.00	0.00		
Poor	70	4 (5.7)	0.171	[0.045, 0.655]		
Season	**692**	**9 (1.3)**			**0.500**	**0.479**
Dry	388	4 (1.0)	Ref	Ref		
Wet	304	5 (1.6)	0.623	[0.166, 2.340]		

BCS = Body Condition Score; Ref = Reference; OR = Odd Ratio; CI = Confidence Interval

4.3.Cysts of Major Metacestodes

The prevalence of bovine hydatidosis in the present study was found to be 9.1% (63/692). There was no significant association (P>0.05) in hydatid cyst prevalence and host risk factors such as seasons of the year and sex of cattle. However, significant association was observed among breeds, age and body condition of cattle (P<0.05). Higher prevalence was recorded in cross breed cattle (17.2%) than local breed (8.3%). Cyst prevalence was recorded in 1.7% of young and 10.6% of adult cattle. Higher cyst prevalence was recorded in cattle with poor (15.7%) followed by medium (9.5%) and good body condition scores (4.4%) (Table 3).

Table 3. Prevalence of bovine hydatidosis based on different host risk factors

Variables	No. examined	Prevalence (%)	OR	95% CI	χ^2	P-Value
Breed	**692**	**63 (9.1)**			**5.569**	**0.018**
Cross	64	11 (17.2)	Ref	Ref		
Local	628	52 (8.3)	2.299	[1.132, 4.670]		
Sex	**692**	**63 (9.1)**			**0.509**	**0.476**
Female	70	8 (11.4)	Ref	Ref		
Male	622	55 (8.8)	1.330	[0.606, 2.921]		
Age	**692**	**63 (9.1)**			**9.437**	**0.002**
Young	118	2 (1.7)	Ref	Ref		
Adult	574	61 (10.6)	0.145	[0.035, 0.602]		
BCS	**692**	**63 (9.1)**			**7.391**	**0.025**
Good	136	6 (4.4)	Ref	Ref		
Medium	486	46 (9.5)	0.248	[0.087, 0.701]		
Poor	70	11 (15.7)	0.561	[0.275, 1.143]		
Season	**692**	**63 (9.1)**			**0.032**	**0.857**
Dry	388	36 (9.3)	Ref	Ref		
Wet	304	27 (8.9)	1.049	[0.622, 1.771]		

BCS = Body Condition Score; Ref = Reference; OR = Odd Ratio; CI = Confidence Interval

The overall prevalence of hydatid cyst in both goats and sheep was found to be 11.8% (9/76). However, the prevalence of hydatid cyst was 14.3% (4/28) in goats and 10.4% (5/48) in sheep.

The prevalence of hydatid cyst was slightly higher in goats than sheep though there was no statistical significant difference (P>0.05).The prevalence of *C.cerebralis* in goats and sheep in this study was 2.6% (2/76). The association of host risk factors to prevalence of H. cyst and *C. cerebralis* in small ruminants was not statistically significant (P>0.05) except BCS risk factors.

Table 4. Prevalence of hydatid cyst and *Coenurosis cerebralis* in small ruminants

Variables	No. examined	H. cyst prevalence (%)	*C.cerebralis* prevalence (%)	OR	95% CI	χ^2	P-Value
Species	**76**	**9 (11.8)**	**2 (2.6)**			**0.410**	**0.522**
Caprine	28	4 (14.3)	1 (3.6)	Ref	Ref		
Ovine	48	5 (10.4)	1 (2.1)	1.522	[0.418, 5.534]		
Sex	**76**	**9 (11.8)**	**2 (2.6)**			**0.018**	**0.895**
Female	22	3 (13.6)	0 (0)	Ref	Ref		
Male	54	6 (11.1)	2 (3.7)	0.908	[0.217, 3.798]		
Age	**76**	**9 (11.8)**	**2 (2.6)**			**0.035**	**0.851**
Young	19	2 (10.5)	1 (5.3)	Ref	Ref		
Adult	57	7 (12.3)	1 (1.8)	1.148	[0.272, 4.857]		
BCS	**76**	**9 (11.8)**	**2 (2.6)**			**7.992**	**0.018**
Good	15	0 (0)	0 (0)	Ref	Ref		
Medium	43	3 (7)	2 (4.7)	0.00	0.00		
Poor	18	6 (33.3)	0 (0)	0.263	[0.068, 1.018]		
Season	**76**	**9 (11.8)**	**2 (2.6)**			**0.275**	**0.600**
Dry	36	4 (11.1)	1 (2.8)	Ref	Ref		
Wet	40	5 (12.5)	1 (2.5)	0.685	[0.165, 2.836]		

BCS = Body Condition Score; Ref = Reference; OR = Odd Ratio; CI = Confidence Interval; H. cyst = Hydatid cyst; *C. cerebralis = Coenurosis cerebralis*

Cysts were found to be distributed in different organs and muscles as depicted by (Table 5).

Table 5. Distribution of cysts in different organs/muscles

Cysts	No. examined	Organs/Muscle	No. positive Organs/Muscle	Prevalence (%)
C. bovis	692	Diaphragm	1	0.14
	692	Heart	2	0.29
	692	Masseter	1	0.14
	692	Tongue	2	0.29
	692	Triceps	3	0.43
Hydatic cyst	768	Lungs	47	6.12
	768	Liver	20	2.60
	768	Kidneys	5	0.65
C. cerebralis	76	Head	2	2.63%

4.4.Characterization of Cyst

The viability of the *C. bovis* cyst were conducted and from the total 9 cysts 6(66.67%) were viable and 3(33.33%) were non-viable. Among the viable cysts 2(33.33%) tongue, 2(33.33%) triceps, 1(16.67%) masseter and 1(16.67%) heart were recorded. The hydatid cyst characterization was carried out in different organs. Of 183 cysts counted and evaluated, 82% (150/183) of them were fertile and contained protoscolices whereas the remaining 18% (33/183) were infertile. Of the total cysts, 63.9% (117/1183) of them were viable and 18% (33/183) were non-viable, 8.2% (15/183) were sterile and 9.8% (18/183) were calcified cysts. From a total of 183 recorded hydatid cysts, 18 were calcified cysts which reduce the total number of cysts to be assessed for size. Acordingly 54.54% (90/165) were small, 29.1% (48/165) medium and the rest 16.36% (27/165) were large in size (Table 6).

Table 6. Hydatid cyst counts, size, fertility and viability in different organs

Organs affected	No of Organs	No of cyst%	Cyst size			Fertile cyst		Unfertile cyst	
			Small	**Medium**	**Large**	**Viable**	**Non-viable**	**Sterile**	**Calcified**
Kidney	5	5(2.73)	3(1.82)	2(1.2)	0	4(2.2)	0	1(0.55)	0
Liver	20	41(22.4)	15(10.9)	15(9.1)	7(4.24)	30(16.4)	6(3.3)	1(0.55)	4(2.2)
Lung	47	137(74.86)	72(43.64)	31(18.8)	20(12)	83(45.35)	27(14.7)	13(7.1)	14(7.65)
Total		**183(100)**	**90(54.54)**	**48(29.1)**	**27(16.36)**	**117(63.93)**	**33(18.03)**	**15(8.2)**	**18(9.84)**

4.5.Retrospective Study

4.5.1. Prevalence

The retrospective meat inspection data analysis of 26246 slaughtered cattle over the last three and half years showed an overall cyst prevalence of 9.3% (2441/26246). The prevalence of *C. bovis* was found to be 0.62% (162/26246) while that of hydatid cyst was shown to be 8.68% (2279/26246). Higher occurrence of *C. bovis* and hydatid cyst was observed among adult age group, poor body conditioned animals and those animals slaughtered in wet season ($P<0.05$) than young age groups, medium and good body conditioned animals and animals slaughtered in the dry seasons ($P>0.05$). There was no significant difference ($P>0.05$) in cross and local breeds as well as male and female animals (Table 7).

Table 7. Retrospective data of *C. bovis* and H. cysts recorded in slaughtered animals at Debre Berhan municipality abattoir (2009-mid 2012 EC)

Risk factors	N<u>o</u> of Animals	*C. bovis* (%)	H. cyst (%)	OR	95%CI	χ2	P-value
Breed	**26246**	**162(0.62)**	**2279(8.68)**			**0.49**	**0.488**
Cross	2084	16(0.77%)	169(8.11%)	Ref	Ref		
Local	24162	146(0.60%)	2110(8.73)	0.946	0.808, 1.107		
Sex	**26246**	**162(0.62)**	**2279(8.68)**			**2.620**	**0.106**
Female	2316	19(0.82%)	218(9.41%)	Ref	Ref		
Male	23930	143(0.6%)	2061(8.61%)	1.124	0.976, 1.294		
Age	**26246**	**162(0.62)**	**2279(8.68)**			**21.123**	**0.000**
Young	1967	7(0.36%)	119(6.05%)	Ref	Ref		
Adult	24279	155(6.4%)	2160(8.9%)	1.540	1.279, 1.854		
BCS	**26246**	**162(0.62)**	**2279(8.68)**			**15.246**	**0.000**
Good	4848	18(0.37%)	376(7.76%)	Ref	Ref		
Medium	15560	89(0.57%)	1355(8.71%)	0.768	0.672, 0.877		
Poor	5838	55(0.94%)	548(9.4%)	0.888	0.803, 0.982		
Season	**26246**	**162(0.62)**	**2279(8.68)**			**6.881**	**(0.009)**
Dry	13308	68(.51%)	1108(8.33%)	Ref	Ref		
Wet	12938	94(0.73%)	1171(9.05%)	0.894	0.823, 0.972		

BCS = Body Condition Score; Ref = Reference; OR = Odd Ratio; CI = Confidence Interval; H. cyst = Hydatid cyst; *C. bovis* = *Cysticercus Bovis*

Multivariable logistic regression analysis of the abattoir record is depicted by (Table 8).

Table 8. Multivariable logistic regression analysis of host risk factors in relation to the outcome

Risk factors		**No. examined**	***C. bovis* (%)**	**H. cyst (%)**	**COR**	**AOR**	**P- Value**
Breed	Cross	2084	16(0.77%)	169(8.11%)	1.060	Ref	
	Local	24162	146(0.60%)	2110(8.73)		1.090	0.357
Sex	Female	2316	19(0.82%)	218(9.41%)	0.890	Ref	
	Male	23930	143(0.6%)	2061(8.61%)		0.880	0.114
Age	Young	1967	7(0.36%)	119(6.05%)	1.540	Ref	
	Adult	24279	155(6.4%)	2160(8.9%)		1.540	0.000
Body condition score	Good	4848	18(0.37%)	376(7.76%)	1.140	Ref	
	Medium	15560	89(0.57%)	1355(8.71%)		1.150	0.021
	Poor	5838	55(0.94%)	548(9.4%)		1.290	0.000
Season	Dry	13308	68(.51%)	1108(8.33%)	1.120	Ref	
	Wet	12938	94(0.73%)	1171(9.05%)		1.120	0.007
Total		**26246**	**162 (0.62%)**	**2279 (8.68%)**			

COR = Crude Odds Ratio; AOR = Adjusted Odds Ratio CI = Confidence Interval;

H. cyst = Hydatid cyst; *C. bovis = Cysticercus Bovis*

4.5.2. Estimation of economic loss

The direct loss was assessed based on recorded data on the number of organs condemned and the average retail price in a given time. To do this, abattoir based recorded retrospective data for the last three and half years were used. Hence, 1631 lungs, 712 liver, 153 kidneys, 31 heart, 14 diaphragm, 26 tongue and 19 head were condemned and recorded in the abattoir condemned organs recording book. The reason of condemnation of organs was infection with bovine cysticercosis and hydatidosis. Based on data on the number of cattle condemned organs during the study period and their average retailed market price, the direct economic loss was calculated to be 132, 645 Ethiopian Birr (ETB). The indirect economic loss was estimated based on the total number of cattle slaughtered (26246), prevalence of cysticercosis (0.62%) and hydatidosis (8.68%), average price of 1kg of beef (200 ETB), dressed average carcass weight of adult zebu cattle (126 kg) and a reduction of 5% in meat production due to metacestodes. Then it was found to be 177,969296.74 ETB. The total economic losses in the last three and half years due to bovine cysticercosis and hydatidosis at Debre Berhan municipality abattoir was calculated based on the summation of the direct economic loss due to organ condemnation and indirect economic loss due to carcass weight loss. Hence, the total economic loss was found to be 178,101,941.74 ETB (Table 9).

Table 9. The economic loss of organs condemned as a result of *C. bovis* and hydatid cyst at Debre Berhan municipality abattoir (2009-mid 2012 EC)

Years	**Organs**	**Lungs**	**Liver**	**Kidneys**	**Heart**	**Diaphragm**	**Tongue**	**Head**	**Total**
	NCO	422	205	34	11	4	5	7	
2009	AUP	45	40	40	30	40	30	60	
EC	TP	18990	8200	1360	330	160	150	420	
	NCO	496	229	54	5	3	9	6	
2010	AUP	50	45	50	35	50	35	70	
EC	TP	24800	10305	2700	175	150	315	420	
	NCO	491	215	46	7	5	8	4	
2011	AUP	60	50	60	40	60	40	80	
EC	TP	29460	10750	2760	280	300	320	320	
	NCO	222	63	19	8	2	4	2	
2012	AUP	65	55	65	45	65	45	90	
EC	TP	14430	3465	1235	360	130	180	180	
	Total	**87680**	**32720**	**8055**	**1145**	**740**	**965**	**1340**	**132645**

NCO = number of condemned organs; AUP = average unit price and TP = total price

4.6.Questionnaire Survey

Volunteer respondents (n = 100) in Debre Berhan town indicated that 33% (33/100) of them acquired *T. saginata*. The association of taeniasis to host risk factors such as sex, literacy, occupation and meat consumption habit was statistically significant (P<0.05). However, there was no statistical significant association (P>0.05) of taeniasis prevalence with age of participants and availability of latrine/toilet (Table 10).

Table 10. Analysis of risk factors associated with the prevalence of *T. saginata* at Debre Berhan town during the study period

Variable		**No. examined**	***T. saginata* (%)**	**OR**	**95% CI**	**$\chi 2$ (P-Value)**
Sex	Female	30	5(16.67%)	Ref	Ref	5.171
	Male	70	28(44.28%)	33.330	1.100, 9.700	(0.023)
Age	<15 years	8	1(12.5%)	Ref	Ref	2.526
	15-29 years	22	8(36. 36%)	5.444	0.537, 55.230	(0.471)
	30-40 years	54	17(31.48%)	1.363	0.365, 5.072	
	>40 years	16	7(43.75%)	1.693	0.540, 5.306	
Literacy	More ducated	59	12(20.34%)	Ref	Ref	10.433
	Less educated	41	21(51.22%)	0.243	0.101, 0.587	(0.001)
Occupation	Low risk	57	11(19.3%)	Ref	Ref	11.256
	High risk	43	22(51.16%)	0.228	0.094, 0.555	(0.001)
Latrine	Not available	14	3(21.43%)	Ref	Ref	0.986
	Available	86	30(34.88%)	0.509	0.132, 1.967	(0.321)
Meat consumption habit	Properly cooked	22	3(13.64%)	Ref	Ref	20.845
	Partially cooked	39	6(15.38%)	12.667	2.775, 57.828	(0.000)
	Raw and partially cooked	18	8(44.44%)	9.143	2.695, 31.014	
	Raw beef	21	13(61.9%)	2.000	0.548, 7.301	
Total		**100**	**33 (33%)**			

An attempt was made to know about the levels of awareness and perception of the community about zoonotic tapeworms. Accordingly, 44% (56/100) of volunteer respondents in Debre Berhan town indicated that they did not have knowhow about zoonotic tapeworms while the rest

56% (44/100) of them had. On the other hand, 58% (58/100) of the respondent's did not know about the fatality of tapeworms but 42% (32/100) of them did. An enquiry geared to know about access to inspected meat during holidays revealed that 71% (71/100) of them did not get their meat inspected indicating the widespread experience of backyard slaughtering in Debre Berhan town. Generally, there was low level of community awareness and perception in Debre Berhan town towards the transmission of zoonotic tapeworms to humans which was attested by their consumption of raw beef, raw and partially cooked beef and partially cooked beef. However, it was indicated that few participants consumed properly cooked beef. In general, 92% (92/100) of participants believed deworming as a means to control tapeworm infection. Hence, there is a significant difference in knowledge gap among participants about zoonotic risk of tapeworms, their fatality and means of control (Table 11).

Table 11. Assessment of community awareness/perception about zoonotic tapeworms

Variables	**Response**	**N**	**More favorite type of meat**				**χ2**
			Raw beef	Raw and partially cooked	Partially cooked	Properly cooked	**(P-Value)**
Knowledge about tapeworms	Yes	56(56%)	2(3.57)	5(8.93)	30(53.57)	19(33.93)	39.389
	No	44(44%)	19(43.18)	13(29.54)	9(20.45)	3(6.81)	(0.000)
Is tapeworm a fatal disease?	Yes	32(32%)	5(15.62)	8(25)	12(37.5)	7(21.87)	7.451
	No	58(58%)	15(25.86)	6(10.34)	4(6.89)	12(20.68)	(0.281)
	Don't know	10(10%)	1(10)	4(40)	3(30)	2(20)	
Access to inspected meat during holiday is limited	S.disagree	19(19%)	2(10.52)	2(10.52)	8(42%)	7(36.84)	20.735
	Disagree	46(46%)	6(13.04)	7(15.21)	22(47.82)	11(23.91)	(0.054)
	Undecided	6(6%)	2(33.33)	2(33.33)	2(33.33)	0	
	Agree	25(25%)	8(32)	7(28)	6(24)	4(16)	
	S.agree	4(4%)	3(75)	0	1(25)	0	
Deworming helps to decrease having tapeworm	Yes	8(8%)	0	0	7(87.5)	1(12.5)	8.993
	No	92(92%)	21(22.82)	18(19.56)	32(34.78)	21(22.82)	(0.029)

N = number of respondents

5. DISCUSSION

5.1.Metacestodes

The prevalence of metacestodes in ruminants at Debre Berhan municipality abattoir was determined with the associated risk factors by employing active abattoir and questionnaire surveys and retrospective data analysis. The overall prevalence of metacestodes in the current study10.8% (83) is higher than that of Gondor and Tembo (2001) who reported 3.1% prevalence in central Ethiopia, 1.05% (Dutra *et al.*, 2012) in Brazil, 3% (Garedaghi *et al*., 2011) in Iraq, 1.6% (Basem *et al*., 2009) in Egypt, 1.08% (Abuseir *et al.*, 2006) in Germany and 0.2% (Dzoma, 2011) in South Africa. However, it is lower than 26.25% (Abunna *et al.*, 2007), 18.49% (Kebede, 2008), 17.5% (Hailu, 2005) and 22.9% (Mesfin and Nuradddis, 2012) in different parts of Ethiopia. The factors of poor socio-economic status, traditional feeding habits together with back yard slaughtering practice may increase the prevalence and transmission rate of the disease.

Higher number of cysts of *C.bovis* in this study was encountered in the triceps, heart, tongue, diaphragm, and masseter muscles. Getachew (1990), Hailu (2005) and Dawit *et al.* (2012) observed cysticerci in triceps, masseter and heart muscles in various endemic areas of Ethiopia. In addition, another study demonstrated tongue, heart and masseter muscles to be the most frequent locations for cysticerci (Garedaghi *et al.*, 2012).

The variation in prevalence and distribution of cysts in different organs between the current and previous studies might be attributed to the method and quality of meat inspection, ability of meat inspectors to identify cysts, difference in animal husbandry, sample size and sampling method, the number of cuts, culture and feeding habit of people.

The custome of eating raw beef by the people of Debre Berhan town is a deep rotted tradition. Toilets are scarcely available and human excreta are disposed here and there. Animals are in search of grazing in an open natural pasture. Contamination of grazing land by human excreta containing *T. saginata* eggs may lead to subsequent infection of the intermediate host (cattle). Lower prevalence of bovine cysticercosis in this study might be attributed to inexperience in detection skill of cysticerci from their predilection sites and is paradoxical in the presence of optimum risk factors precipitating the disease. The prevalence of bovine cysticercosis in cattle is highly correlated with the prevalence of taeniasis in human beings in same area since humans with taeniasis are source of infection to cattle.

Bovine cysticercosis occurred in low prevalence which is in agreement with Ibrahim and Zerihun (2012), but in contrary to the finding of Basem *et al.* (2009) in Ethiopia. This might be due to age dependent immunity of an animal that had an important role in fighting against infestation and re-infestation by *C. bovis*. In addition, re-stimulation of animal's immunity following continuous invasion and development of a strong immunity which did not allow further development of more cysticerci from invading infestation may contribute (Wanzala *et al.,* 2003). *C. bovis* infestation occurred in local, but no *C. bovis* was found in cross breed cattle. Fewer cross breed cattle were slaughtered during the current study duration.

The prevalence of *C. bovis* within body conditions; of the 136 good body conditioned animals there was no positive records, 1.03% (5/486) in medium body condition and 5.71% (4/70) in poor body condition were recorded. This result reveals statistically significant association between *C. bovis* infestation and body condition of animals. Our finding was in agreement with previous reports of Mesfin and Nuraddis (2012) from different regions of the country. The likely reason for lower prevalence in animal with good body condition may be due to good body conditioned cattle in the abattoir were brought from fatting systems of the individual farmers, in which there will be deworming of animals and limited movements for free grazing on pasture land. Accordingly those cattle were less exposed to *T. saginata* eggs and have low prevalence rate for bovine cysticercosis.

There was no association between *C. bovis* infestation and sex of animals which might be due to few numbers of females involved in this study. This finding is in agreement with the report of Belachew and Ibrahim (2012) in Ethiopia, Garedaghi *et al*. (2011) in Iran and Dzoma *et al.* (2011) in Nigeria. But this finding is not in line with study carried out in Ethiopia where Ibrahim and Zerihun (2012) and Nuraddis and Frew (2012) reported significant association between sexes of slaughtered animals and infestation rate with *C. bovis.*

Hydatidosis was another disease encountered at Debre Berhan municipality abattoir. It affects most of the visceral organs such as lungs, liver, heart and kidneys. The current study revealed moderate prevalence of bovine hydatidosis which is congruent to 9.4% (Regassa *et al.*, 2009) in Harar, 8.56% (Lahmar *et al.*, 2012) in Tunisia, 7.4% (Sariozkan and Yalcin, 2009) in Turkey and 6% (Omer *et al.,* 2010) in Sudan. The current result is higher than 4.2% (Nonga and Karimuribo, 2009) in Tanzania and 2.8% (Sahar and Atif, 2011) in Sudan. However, it is lower than 61% (Koskei, 1998) in Assela, 48.7% (Ernest *et al.,* 2009) in Tanzania, 16% (Kebede *et al.*, 2009) in Wolaita Sodo, 22% (Kebede *et al.*, 2009) in Tigray, 48.9% (Kebede *et al.*, 2009) in Debre Markos, 32.1% (Berhe, 2009) in Mekelle, 17.5% (Alemu *et al.*, 2013) in Wollo, 40.5% (Dechassa *et al.*, 2012) in Addis Ababa and 33.5% (Wubshet and Mahendra, 2016) in Kombolcha.

The high prevalence of haydatid cyst elsewhere could be related to slaughtering of aged cattle which have had considerable chance of exposure to the parasitic ova, backyard slaughtering of small ruminants and provision of infected offals to pet animals around homesteads. Such high prevalence of hydatidosis could be attributed to lack of proper public awareness about transmission of the disease and presence of few slaughterhouses (widespread backyard slaughter).

There was no association in hydatidosis infection rate and sex of animals. This may be due to indiscriminate exposure of animals to risk factors irrespective of their sexes. The management of both female and male animals in an open range land subjects them to equal chance of infection. This finding is not supported by Mebrahtu and Mesele (2012) who reported more occurrence of the disease in females than males because female animals are not slaughtered in younger ages as long as they are fertile. Female animals are sent to abattoir after milking and getting calves for years. Old animals were highly infected (Miheret *et al.,* 2013) which is in agreement to the current finding. This could be mainly due to their longer exposure to *E. granulosus* and lower immunity against infection. Animals with poor body condition are highly infected followed by medium and good (Melaku *et al.*, 2012) body conditions parallel to the present finding.

Hydatid cyst was frequently encountered in the lungs, liver and kidneys in order of occurrence. The fact that hydatid cysts showed greater preference for lung and liver than other viscera could be related to presence of the dense capillary networks in these organs which filter out and retain the oncosphere of *E. granulosus* before being encountered in peripheral organs.

Cysts in the current study were evaluated and characterized. The predominant size of the cysts was seen to be small. With regard to fertility and viability condition of cysts, around 63.9% were found to be viable, 18% non-viable, 8.2% sterile and 9.84% calcified. The fertility rate of cysts was higher in lungs than liver due to softer consistency of lung tissue which allows easier development of the cysts and favors their fertility rate (Getaw *et al.*, 2010).

The prevalence of hydatidosis and *C. cerebralis* in sheep and goats has seen to be 14.47%. The prevalence of *C. cerebralis* in sheep and goats was 2.6% in this study. The study done at Ethiopian Health nd Nutrition Research Institute (EHNRI), Addis Ababa by Asefa *et al.* (2012) was reported 4.7% *C. cerebralis cysts* in sheep. The *C.cerebralis* prevalence 2.3% and 12.44% in sheep and goats, respectively, was also reported by Adem (2006) in Ashim export abattoirs in Ethiopia. The result of the current study in sheep is consistent with the report of Abo-Shehada in Jordan (3% in sheep), Varma & Malviya (1989) in India (2.88% in sheep). But this is slightly lower than Sharma &Chauhan (2006) in Ethiopia 5% (in sheep) and Oryan *et al.* (1994) in Iran 9.8% (in sheep). The variation in infestation rate could be accredited to the distribution of carnivors and environmental factors that affect the survival of the worm's egg on pasture.

The rate of infection of *Echinococcus granulosus* of sheep and goat in our study (11.84%) was inageement to the overall infection rate of 14.7% reported by Yousefi *et al.* (2007) in Iran, the higher rate of infection was recorded in North Jordan 27.8% (Abdel-Hafez *et al.,* 1986), in Italy, Scala and Varcasia (2006) established a very high incidence of 75%. In other studies, lower infection rates were reported: 0.3% (Haridy *et al.,* 2005) and 0.66% (Abu-Elwafa *et al.*, 2009) in Egypt, 2.7% (Arbabi & Hooshyar, 2005) in Kashan region of Iran. The most probable reason for the variation of the results in different countries is supposed due to variations in climatic, geography, management of the study animals and the final dog hosts and social conditions.

The seasonal variation in the abattoir survey of metacestodes in the present study was not statistically significant. The higher prevalence of CE was recorded in dry season than wet season it could be explained by temperature differences that can limit the survival of the eggs (Otero-abad and Torgerson, 2013). The seasonal variation could be related to free roaming dogs infected with *E. granulosus* contaminating green pasture from June to September which corresponds to the rainy season in Ethiopia followed by infection and subsequent developments of cysts in the cattle host in the following months (Daryani *et al.,* 2007). We note that this seasonal variation should be interpreted with caution since the life cycle of the parasite are long and involves two developmental stages.

5.2.Economic Loss

Retrospective study was conducted at Debre Berhan Municipality abattoir. The source of this information was recorded data for the last three and half years at Debre Berhan municipality abattoir. In the record, host related data, condemned organs, reasons of condemnation and total animals slaughtered were recorded. The economic loss due to bovine cysticercosis and bovine hydatidosis was estimated altogether due to lack of independent abattoir record for these two diseases. The direct economic loss is the loss associated with condemned organs and it is easy to calculate. On the other hand, the indirect economic loss is the loss associated to reduce carcass weight which is difficult to calculate. The total economic loss is the summation of these two losses altogether.

The direct economic loss was estimated to be 132, 645 ETB. On the other hand, the indirect economic loss was estimated to be 177,969,296.74 ETB. The total economic was estimated to be 178,101,941.74 ETB. The indirect economic loss in this study was significantly higher than direct economic loss indicating the widespread nature of metacestodes and higher degree of livestock infestation rate in Debre Berhan town. Poor veterinary sevices, resistance to the commonly used anthelmintics, the widespread nature of stray dogs, absence of toilets in majority of the households and roaming of animals in an open pasture might be incriminated as major reasons for the exaggerable indirect economic loss documented in the current study.

Different economic losses regarding metacestodes were also reported from different parts of the Ethiopia. Yilma and Gebreab (1984) reported an annual total loss of 813,526.46 ETB at Debre Zeit Municipal abattoir, 90,646.95 ETB (Elisa *et al.,* 1985) in Gonder Municipal abattoir and 77, 587.02 ETB (Feyissa, 1987) in Nekemte municipal abattoir. These differences in various abattoirs or regions may be due to variation in the prevalence of the disease, mean annual slaughtered cattle in different abattoirs and variations in the retail market price of liver, lungs, heart, kidneys and beef. In addition to losses experienced in the abattoir, metacestodes could have economic impact due to invisible losses like impaired productivity; for example, reduced traction power of oxen which results in reduced crop production and reduction of milk production in dairy cows. Moreover, cost of control, loss of life, productivity and treatment cost in human magnifays the economic losses. From the above data and day-to-day abattoir observation by veterinarians, it can be speculated that these parasitic diseases are the major cause of losses in livestock production and productivity.

5.3.Public Health

Pretested structured and close-ended questionnaire to avoid bias was administered in face-to-face modality to assess the infection rate and public awareness towards zoonotic tapeworms. The respondents who were questioned in this study disclosed their finding of proglottids in their faeces and underwear indicating the presence of *T. saginata* in particular and the importance of taeniosis in general in Debre Berhan town. This is based on the guidelines adopted by OIE (2004) which stated *T.saginata* is known by its more frequent expulsion through anus.

There was strong association in prevalence of *T. saginta* infection and age of the respondents in the present study. Taeniosis occurred in above 20 years /in adults/ of age than younger ones implying that the habit of raw meat consumption increases with age. Younger people (mostly students) cannot afford to buy beef for raw consumption. Raw meat is mostly consumed at the butcher's house and it is more expensive due to its high quality and demand by others than the one that is taken away for preparation at home. The current result was also supported by Cabaret *et al.* (2002) who reported high prevalence of *T. saginata* /cysticercosis/ especially in East Africa and generally in sub-Saharan Africa.

The prevalence *T. saginata* infection in relation to gender of patients showed that significantly higher proportions of males were infected than females. In agreement with the current results, previous questioner based study in Ethiopia showed that males were at higher risk for *T. saginata* infection compared with females (Dawit, 2004; Hailu, 2004; Mulugeta, 2012). The reason for this significantly advanced prevalence in males may be due to economical reasons and cultural practices in Ethiopia that adult men groups often enjoy raw beef (*Kurt*) consumption in butchers and restaurants then than women, accordingly males have higher probability of getting viable cysticerci infection.

In the present study there was statistically significant varation among different meat consumption habits and the occurrence of *T. saginata*. The highest prevalence is recorded in peoples were favored for raw beef meat consumption habit. Ingestion is the major mode of transmission of *T.saginata* infection from animals to humans by eating raw or undercooked meat in traditional dishes like ***kitifo*** and ***kurt*** in Ethiopia. Humans acquire infection by inadvertent consumption of ova or larval stages (metacestode) present in undercooked meat (Jia *et al.*, 2010). *Cysticercus bovis*, the metacestode of *T. saginata*, occurs only in beef and humans are only the definitive hosts and acquire infection by ingestion of raw meat containing cysticeri (Oryan *et al*., 1998; Nunes *et al*., 2013).

6. CONCLUSION AND RECOMMENDATIONS

Metacestodes are known to have veterinary and medical importance in different parts of the world. It is a problem of significant order meriting attention and implementation of control programme. In order to establish a rational control strategy, sound local epidemiological knowledge and understanding significance of the disease are of critical importance. Metacestodes are the causes of organ condemnation in domestic ruminants and hence direct economic losses to butchers. Infection in live domestic ruminants causes reduction in production and productivity and hence indirect economic losses to livestock farmers which are difficult to calculate.

The present study clearly demonstrated the occurrence of metacestodes in ruminants in moderate prevalence in Debre Berhan town. Moreover, metacestodes have got significant economic impact interms of impairing the livestock production and productivity in Debre Berhan town. Moreover, it has public health impacts in residents of the town. The level of public awareness and perception to the mode of transmission of zoonotic tapeworms to human beings and their fatality was found to be low. The presence of metacestodes at moderate prevalence together with low level of public awareness towards their zoonotic risk indicated an eminent potential dager to residents in Debre Berhan town.

Based on the above concluding remarks the following recommendations can be forwarded with the view to reduce the current impact of metacestodes in ruminants and humans at Debre Berhan town:

- ❖ There should be public awareness campaign to increase the level of knowledge on parasitic zoonoses through home-to-home discussion and training of households about the effects of metacestodes in animals and humans.
- ❖ Strategic deworming of cattle, goats sheep and pets (dogs and cats) with appropriate anthelmintics at appropriate time has to be seriously implemented.
- ❖ Stray dogs' control programme should be mounted in order to reduce their number to the minimum and break the life cycle of cestodes. Moreover, there should be proper disposal (deep burial/incineration) of condemned visceral organs in order to avoid their consumption by dogs, cats and hyenas.

- The efficiency of abattoir meat inspection should be enhanced by training using FAO manual developed to train meat inspectors in developing countries. Moreover, the right number of meat inspectors should be allocated in proportion to the workload.
- There should be one health approach between veterinarians and human health professionals in defining and managing zoonotic parasitic cestodes.
- There has to be good livestock husbandry practices such as zero-grazing and reduce contact of ruminants with cats and dogs.

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8. APPENDICES

8.1.Questionnaire Survey

Debre Berhan University, School of Graduate Studies

Questionnaires to assess community awareness about zoonotic tapeworms

Dear respondent, my name is Dawit Akeberegn and I am conducting a research as part of the MSc program in Debre Berhan University. The topic of my research is **"the impact of metacestodes in ruminants slaughtered at Debre Berhan municipality abattoir."** This questionnaire is designed to obtain information on perception, opinion, experience and knowledge about the topic under study. I confirm you that the information that you share me will be kept confidential and only be used for the research purpose. So, you are kindly requested to provide genuine responses. Hence, I would like to thank you in advance for your kind cooperation and dedicating your time.

Instruction

- ✓ No need of writing your name
- ✓ For closed-ended questions, you are kindly requested to encircle the letter (choice) in each question that holds your opinion.
- ✓ For open-ended questions, you write your opinion in the space provided.
- ✓ For Likert scale type statements, indicate your answers with a check mark (√) in the appropriate block.

Thank you in advance

Part I: Sample Households Information

1. Sex: A. Male B. Female
2. Age: ____________________ years old.
3. Marital Status: A. Single B. Married C. Divorced
   D. Widowed/widower F. Other, specify ___________________________
4. Educational Level:
   A. Illiterate
   B. Primary school (1-8)
   C. Secondary school (9-10)
   D. Preparatory school (11-12)
   E. College diploma
   F. First degree and above
   G. Other, specify ______

5. Occupation: A. Student B. Merchant C. Government employee D. Private employee E. Abattoir worker/butcher
6. What is your monthly income (in Birr)? ___________________________
7. Do you have latrine (toilet) facility at home? A. Yes B. No

Part 2. Questions asking about the respondents' awareness of diseases

8. Do you have the knowledge about the disease called tapeworm? A. Yes B. No
9. Do you have meat consumption habit? A. Yes B. No
10. If the answer is yes for Q9 what type of meat is more favorite for you?
    A. Raw beef B. Raw and partially cooked C. Partially cooked
    D. Properly cooked E. Other, specify ___________.
11. Do you believe that tapeworm can be fatal disease? A. Yes B. No
    C. I do not know
12. Have you ever suffered from tapeworm in the past three years? A. Yes B. No

Part 3: Questions about perceived benefits and barriers of the disease

Major perceived benefits and barriers are listed below. After you read each of the benefits and barriers, evaluate them and then put a tick mark (√) under the choices below. Reference: 5 = strongly agree, 4= Agree, 3 = Undecided, 2 = disagree, 1= strongly disagree

No.	**Benefits**	**Alternatives**				
13	If I eat cooked meat all the time, I will decrease the chance of having tapeworm	5	4	3	2	1
14	Taking of regular deworming helps to decrease the chance of having tapeworm and I feel peace of mind					
15	If I do not consume uninspected meat, it helps to decrease the chance of having tapeworms and I will be a good example for others.					
	Barriers					
16	Lack of cooking facilities increase the chance of eating raw meat					
17	Access to inspected meat during holidays is limited					

18	In the case of regular deworming for tapeworm, the protective level of the drug is not trustable					
19	Tapeworm has costy treatment					

Part 4. Questions likelihood protective intention and indication of readiness to action

20. Do you know that tapeworm can be prevented by cooking meat?
    A. Yes B. No C. I don`t know
21. Do you intend not to eat raw/undercooked meat? A. Yes B. No
22. Do you intend not to eat uninspected meat? A. Yes B. No
23. If you want to buy inspected meat, do you know where to buy? A. Yes B. No
24. Do you look for information about tapeworm, to read and think about it when you encounter information about tapeworm? A. Yes B. No C. I don`t know
25. Do you take tablet/deworm yourself regularly? A. Yes B. No
26. If your take tablet/deworm yourself regularly, are you cooperative enough to provide information about your deworming status to others?
    A. Yes B. No C. I don`t know

Thank you for your kindly responses

8. 2. Questionnaire in Amharic

ደብረ ብርሃን ዩኒቨርሲቲ

ድህረ-ምረቃ መርሃ ግብር

ለደብረ ብርሃን ከተማና አካባቢ ነዋሪዎች በኮሶ ትል በሽታ መያዛቸውን እና ስለ በሽታው ያላቸውን ግንዛቤ ለማወቅ የተዘጋጀ ጥናታዊ መጠይቅ

ውድ የጥናቱ ተሳታፊዎች ስሜ ዳዊት አከበረኝ ይባላል፡፡ እናም በደብረ ብርሃን ዩኒቨርሲቲ እየተከታተልኩት ላለው የማስተርስ ፕሮግራም ጥናታዊ ፅሁፍ በመስራት ላይ እገኛለሁ፡፡ የጥናታዊ ፅሁፌ ርዕስ **የኮሶ ትል በሽታ ተፅኖ በደብረ ብርሃን ከተማ ቄራ አገልገሎት የሚታረዱ እንስሳቶች ላይ የሚል ነው፡፡** በዚህም መሰረት ይህ ቃለ መጠይቅ የተዘጋጀው እናንተ ስለ በሽታው ስላላችሁ አረዳድ፡ የግል አስተያየት እና ተሞክሮ መረጃ ለመሰብሰብ ነው፡፡ የምትሰጡኝ መረጃ ሚስጥራውነቱ ተጠብቆ ለዚሂ ጥናታዊ ፅሁፍ ብቻ የሚውል መሆኑን ላረጋግጥላችሁ እወዳለሁ፡፡ ስለዚህ ተክክለኛ የሆነ መረጃ ትሰጡኝ ዘንድ በትህትና እጠይቃለሁ፡፡ በመሆኑም ውድ ጊዜያችሁን ሰውታችሁ ላደረጋችሁልኝ ቀና ትብብር በቅድሚያ ከልብ የመነጨ ምስጋናዬን ላደርስ እወዳለሁ፡፡

ማሳሰቢያ፤

- በመጠይቁ ላይ ስም መፃፍ አያስፈልግም፡፡
- ምርጫ ለሆኑ ጥያቄዎች የምትስማሙበትን ሃሳብ የያዘውን ፊደል እንድትከቡ በትህትና እጠይቃለሁ፡፡
- ምርጫ ላልሆኑ ጥያቄዎች መልሳችሁን በተዘጋጀው ክፍት ቦታ ላይ ይፃፉ፡፡
- በደረጃ ለተቀመጡ ጥያቄዎች መልሳችሁን በተዘጋጀው ክፍተ ቦታ ላይ የራይት ምልክት (√) ያድርጉ፡፡

በድጋሚ ከልብ አመሰግናለሁ

ክፍል 1፤ የተጠያቂዎች ግላዊ መገለጫዎች

1. ፆታ፡ ሀ. ወንድ ለ. ሴት
2. ዕድሜ፡ --------------------- ዓመት
3. የጋብቻ ሁኔት ሀ. ያላገባ/ች ለ. ያገባ/ች ሐ. የተፋታ/ች መ. የትዳር አጋሩ/ሯን በሞት ያጣ/ች
   ሠ. ሌላ ካለ (ቢገለፅ)_______________
4. የትምህርት ደረጃ፡ ሀ. ያልተማረ ለ . የመጀመሪያ ደረደጃ (1-8) ሐ. ሁለተኛ ደረደጃ (9-10)
   መ. መሰናዶ (11-12) ሠ. ቴክኒክና ሙያ ምሩቅ ረ. ዲፕሎማ
   ሰ. መጀመሪያ ዲግሪና ከዚያ በላይ ሸ. ሌላ ካለ ይገለፅ _______

5. ስራ፡ ሀ. ተማሪ ለ. ነጋዴ ሐ. የመንግስት ሰራተኛ መ. የግል ሰራተኛ ሠ. የቄራ/ልኳንዳ ሰራተኛ

6. ወርሃዊ ገቢዎ ስንት ነው? (በብር) ____________________

7. በቤታችሁ ሽንት ቤት አለ? ሀ. አዎ ለ. የለም

ክፍል 2: መላሾች ስለ በሽታው ሁኔታ ያላቸውን ግንዛቤ ለማወቅ የሚጠየቁ ጥያቄዎች

8. ስለ ኮሶ ትል በሽታ የሚያውቁት ነገር አለዎት? ሀ. አዎ ለ. የለም

9. 9. ስጋ የመመገብ ልምድ አለዎት? ሀ. አዎ ለ. የለም

10. ለተራ ቁጥር 9 መልሰዎ አዎ ከሆነ ይበልጥ ለመመገብ የሚመርጡት የስጋ አይነት ምንድን ነው?

ሀ. ጥሬ ስጋ ለ. ጥሬ ስጋና በከፊል የበሰለ ሐ. በከፊል የበሰለ

መ. በአግባቡ የበሰለ ሠ. ሌላ ካለ ይገለፅ ____________________

11. የኮሶ ትል በሽታ ገዳይ በሽታ ነው ብለው ያስባሉ? ሀ. አዎ ለ. አይደለም ሐ. አላውቅም

12. ባለፉት 3 ዓታት ውስጥ በኮሶ በሽታ ታመው ያውቃሉ? ሀ. አዎ ለ. የለም

ክፍል 3: መላሾች በሽታውን ለመከላከል ያላቸውን ጠቃሚ እና ጎጂ የሆኑ አስተሳሰቦችን ለማወቅ የሚጠየቁ ጥያቄዎች

ከዚህ በታች በሽታውን ለመከላከል የሚጠቅሙና ጎጂ ሊሆኑ የሚችሉ ነጥቦች ተዘርዝረዋል፡፡ ከተዘረዘሩት ጥቅሞችና ችግሮች በእርስዎ ላይ ይበልጥ ተፅእኖ የሚያሳድሩትን በደረጃ ያመላክቱ፡፡ ለእያንዳንዱ ጥያቄ ከአማራጮቹ ውስጥ አንድ ጊዜ ብቻ የእርማት (√) ምልክት በማድረግ ምላሽ ይስጡ፡፡ 5 = በጣም እስማማለሁ፤ 4 = እስማማለሁ፤ 3 = ለመወሰን እቸገራለሁ፤ 2 = አልስማማም፤1 = በጣም አልስማማም

ተ.ቁ	ጥቅሞች	አማራጮች				
		5	4	3	2	1
13	ሁሌም የበሰለ ስጋን ብመገብ በኮሶ ትል በሽታ የመያዝ እድሌን እቀንሳለሁ፡፡					
14	በመደበኛ ሁኔታ የጸረ- ተህዋስያን መድሃኒት መውሰድ የኮሶ ትል በሽታ የመያዝ እድልን ለመቀነስ ያግዛል እንዲሁማ የአዕምሮ እረፍት ይሰጣል፡፡					
15	ያልተመረመረ ስጋን ከመብላት በመቆጠብ በኮሶ ትል በሽታ የመያዝ እድሌን እቀንሳለሁ እንዲሁም ለሌሎች ጥሩ ምሳሌ መሆን እችላለሁ፡፡					
	ችግሮች	5	4	3	2	1

16	የማብሰያ እቃዎች እጥረት መኖር ጥሬ ስጋ የመብላት እድልን ይጨምራል፡፡					
17	በበዓላት ወቅት የተመረመረ ስጋ ለማግኘት እጥረት አለ፡፡					
18	የኮሶ ትል በሽታን ለመከላከል መደበኛ የውስጥ ጥገኛ መድሃኒት ለመውሰድ ባስብም የመድሃኒቶቹ የመከላከል አቅም አስተማማኝ አይደለም፡፡					
19	የኮሶ ትል በሽታ መድሃኒት ለመውሰድ መድሃኒቱ በጣም ውድ ነው::					

ክፍል 4: መላሾች በሽታውን ለመከላከልና እርምጃ ለመውሰድ ያላቸውን ፍላጎት ለማወቅ የሚጠየቁ ጥያቄዎች

20. ስጋን አብስሎ በመጠቀም የኮሶ ትል በሽታን መከላከል እንደሚቻል ያውቃሉ?

ሀ. አዎ ለ. የለም ሐ. አላውቅም

21. ከዚህ በሁዋላ ጥሬ/በደምብ ያልበሰለ ስጋ ላለመብላት ወስነዋል? ሀ. አዎ ለ. የለም

22. ከዚህ በሁዋላ ያልተመረመረ ስጋ ላለመብላት ወስነዋል? ሀ. አዎ ለ. የለም

23. እርሶ የተመረመረ ስጋ ለመግዛት ቢፈልጉ ከየት ማግኘት እንደሚችሉ ያውቃሉ? ሀ. አዎ ለ. የለም

24. ስለ ኮሶ ትል በሽታ መረጃዎችን የሚያገኙ ከሆነ ለማንበብና በበሽታው ዙሪያ ይበልጥ ለማወቅ ፍላጎት አለዎት? ሀ. አዎ ለ. የለም ሐ. አላውቅ

25. በሽታውን ለመከላከል መደበኛ የውስጥ ጥገኛ መድሃኒት ለመውሰድ ፍላጎት አለዎት?

ሀ. አዎ ለ. የለም ሐ. አላውቅም

26. ለጥያቄ ተራ ቁጥር 25 መልስዎ አዎ ከሆነ የእርሶን መድሃኒት አጠቃቀም መረጃዎችን ለሌሎች ለማካፈል ፍላጎት አለዎት? ሀ. አዎ ለ.የለም ሐ. አላውቅም

ለሰጡት ምላሽ ከልብ አመሰግናለሁ

8. 3. Body Condition Scoring in Zebu Cattle

Body Condition Scores for cattle that came to abattoir for slaughter were recorded. An assessment of body condition for each animal was made and a score was given. Farm animals were scored using a basic scoring system derived for zebu– like cattle after Nicholson and Butterworth (1986) and interpreted as:

- **BCS 1**: Marked emaciation (animal would be condemned at antemortem examination).
- **BCS 2**: Transverse processes project prominently and neural spines appear sharply.
- **BCS 3**: Individual dorsal spines are pointed to the touch. Hips, pins, tail-head and ribs are prominent. Transverse processes visible usually individually.
- **BCS 4**: Ribs, hips and pins clearly visible. Muscle mass between hooks and pins slightly concave. Slightly more flesh above the transverse processes than in BCS 3.
- **BCS 5**: Ribs are usually visible, little fat cover and dorsal spines barely visible.
- **BCS 6**: Animals are smooth and well covered: dorsal spines cannot be seen but are easily felt.
- **BCS 7**: Animals are smooth and well covered but fat deposits are not marked. Dorsal spines can be felt with firm pressure but feel rounded rather than sharp.
- **BCS 8**: Fat cover in critical areas can be seen easily and felt: transverse processes cannot be seen or felt.
- **BCS 9**: Heavy deposits of fat clearly visible on tail-head, brisket and cod: dorsal spines, ribs, hooks and pins fully covered and cannot be felt even with firm pressure.

Body Condition Scoring is an important part of modern dairy management. BCS after Kellogg (2009) was used for Holstein-Friesian cows, heifers and their crosses and interpreted as follows:

- **BCS 1**: Deep cavity around tail-head. Bones of pelvis and short ribs are sharp and easily felt. No fatty tissue in pelvic or loin area. Deep depression in loin.
- **BCS 2**: Shallow cavity around tail-head with some fatty tissue lining it and covering pin bones and pelvis easily felt. Ends of short ribs feel rounded and upper surfaces can be felt with slight pressure. Depression visible in loin area.

- **BCS 3**: No cavity around tail-head and fatty tissue easily felt over whole area. Pelvis can be felt with slight pressure. Thick layer of tissue covering top of short ribs which can be still be felt with pressure. Slight depression in loin area.
- **BCS 4**: Folds of fatty tissue are seen around tail-head with patches of fat covering pin bones. Pelvis can be felt with firm pressure. Short ribs can no longer be felt. No depression in loin area.
- **BSC 5**: Tail-head is buried in thick layer of fatty tissue. Pelvic bones cannot be felt even with firm pressure. Short ribs covered with thick layer of fatty tissue.

8. 4. Body Condition Scoring in Sheep and Goats

Condition	Score	Description
Starving	0	Extremely emaciated and on the point of death. It is not possible to detect any muscle or fatty tissue between the skin and the bone.
Very thin	1	The spinous process is prominent and sharp. The transverse processes are also sharp, the fingers pass easily under the ends, and it is possible to feel between each process. The eye muscle areas are shallow with no fat cover.
Thin	2	The spinous process feels prominent but smooth, and individual processes can be felt only as fine corrugations. The transverse process is smooth and rounded, and it is possible to pass the fingers under the ends with a little pressure. The eye muscle area is of moderate depth, but has little fat cover.
Moderate	3	The spinous process is detected only as a small elevation; it is smooth and rounded and individual bones can be felt only with pressure. The transverse process is smooth and well covered, and firm pressure is required to feel over the ends. The eye muscle area is full, and has a moderate degree of fat cover.
Fat	4	The spinous processes can just be detected with pressure as a hard line between the fat covered eye muscle area. The end of the transverse process cannot be felt. The eye muscle area is full, and has a thick covering of fat
Very fat	5	The spinous process can't be detected even with firm pressure, and there is a depression between the layers of fat in the position where the spinous process would normally be felt. The transverse process cannot be detected. The eye muscle area is very full with thick fat cover. There may be large deposits of fat over the rump and tail.

Source: Girma and Alemu (2008)

8. 5. Age Estimation of Cattle

Teeth	Cattle age at occurrence		
	Eruption	Full development	Wear
Incisors			
Pinchers	18 to 24 months	24 months	Leveled at 5 to 6 years, noticeable wear at 7 to 8 years
1st intermediate pair	24 to 30 months	36 months	Leveled at 6 to 7 years, noticeable wear at 8 to 9 years
2nd intermediate pair	36 months	48 months	Leveled at 7 to 8 years, noticeable wear at 9 to 10 years
Corners	42 to 48 months	60 months	Leveled at 9 years, noticeable wear at 10 years
Premolars			
1st cheek tooth pair	24 to 30 months		
2nd cheek tooth pair	18 to 30 months		
3rd cheek tooth pair	30 to 36 months		
Molars			
4th cheek tooth pair	5 to 6 months		
5th cheek tooth pair	12 to 18 months		
6th cheek tooth pair	24 to 30 months		

Source: MSU (2013)

8. 6. Age Estimation of Sheep and Goats

Description	Estimated age
Young without teeth often a new born	New born
With erupted and growing 1st pair of milk teeth	2–4 weeks
With erupted and growing 4th pair of milk teeth	6–8 month
With erupted and growing 4th pair of milk teeth	6–8 month
With fully grown milk teeth that started to spread out	9 month

The milk teeth have started to wear down, or are fully spread out	12 months
With erupted and growing 1st pair of permanent teeth	14–17 month
With erupted and growing 2nd pair of permanent teeth	18–23 month
With erupted and growing 3rd pair of permanent teeth	24–36 month
With erupted and growing 4th pair of permanent teeth	3–5 years
The four pairs of permanent incisors have started to wear down	4 years
The permanent incisors have worn down and have started to spread out	5 years
Worn down incisors are spread out and few are lost (broken-mouth)	6 years
Most of the incisors have been lost (smooth-mouth) or worn down to the level of dental pad	7 years

Source: Girma and Alemu (2008)

8. 7. Procedures for Diagnosis of Metacestodes

Meat inspection as the main diagnostic procedure: In general, meat inspection procedures consist of:

I. Visual inspection of the carcass, its cut surfaces and the organs within it. This may reveal *T. saginata, T. solium* and *T. ovis* in the muscles, *T. hydatigena* on the liver, mesenteries or omentum, or *T. multiceps* in the brain.

II. The external and internal masseters and the pterygoid muscles are each examined and one or two incisions made into each, the cuts being parallel to the bone and right through the muscle.

III. The freed tongue is examined visually and palpated, particularly for *T. solium.*

IV. The pericardium and heart are examined visually. The heart usually is incised once length wise through the left ventricle and interventricular septum to exposing the interior and cut surfaces for examination. Incisions may go from the base to the apex and regulations also may require additional, perhaps four, deep incisions into the left ventricle.

Alternately, the heart may be examined externally and then internally after cutting through the interventricular septum and eversion.

i). The muscles of the diaphragm, after removal of the peritoneum, are examined visually and may be incised.

ii). The oesophagus is examined visually.

iii). In some countries, the triceps brachii muscle of cattle is incised deeply some 5cm above the elbow. Additional cuts into it may be made. The gracilis muscle also may be incised parallel to the pubic symphisis. These cuts are usually undertaken for *T. solium* in pigs.

Such incisions into the legs are made, particularly in African countries as it is suspected that more parasites lodge in these muscles in working or range animals walking long distances because of the exercise and consequent increased blood flow to these muscles. Other countries may also require such incisions into the legs. However, as this devalues the meat, such incisions are made most commonly once; one or more cysts have been found at the predilection sites so as to determine the extent of the infection. Overall, the initial incision into any tissue is the most important, but additional incisions may be required either by the regulations or if cysts are found on the initial incision(s). Eichenberger *et al.* (2013) reported an increase in sensitivity by multiple incisions. Additional or fewer procedures may be required for specific parasites and the judgments on the carcass, viscera, offal and blood will vary dependent on Taenia spp. and regulations within a country. Judgments on infected carcasses will fall into three main categories:

i). Approve for human consumption;

ii). Partially condemn and pass the remainder of the carcass, but in the case of the zoonoses, *T. saginata* and *T. solium*, the carcass, meat and viscera must be treated; and

iii). Total condemnation of heavily infected carcasses or emaciated or diseased ones.

8.8. Procedures for cyst fertilility and viablility

Hydatidosis:

1. Obtain/collect non-degenerated hadatid cyst from infected organs of slaughtered animals.
2. Take the cysts to laboratory in cool box.
3. Aspirate hydatyid fluid from the cyst by a sterile 18 gauge needle and transfer to a test tube.
4. The protoscolices allowed to sediment in the fluid for 20-30 minutes which indicates fertility and the supernatant discarded.
5. Confirm the fertility of the cyst by microscope examination of sediment protoscoliices.

6. A drop of sediment contained protoscolices on microscopic glass slide and cover with the cover slip; observe for amoeboid like peristaltic movements with high power objective.
7. For clear vision a drope of 0.1% aqueous eosine solution added to equal volume of protoscolices in Hydatid fluid on the microscopic slide with the principle that viable protoscolices should completely or partially exclude the day while the did ones take it up.
8. Furthermore, infertile cysts where further classified as sterile and calcified. Sterile Hydatid cysts were characterized by their smooth inner lining usually with slightly turbid fluid in its content while typical calcified cysts produce a gritty sound feeling up on incision. Source: (Macpherson *et al.*, 1985).

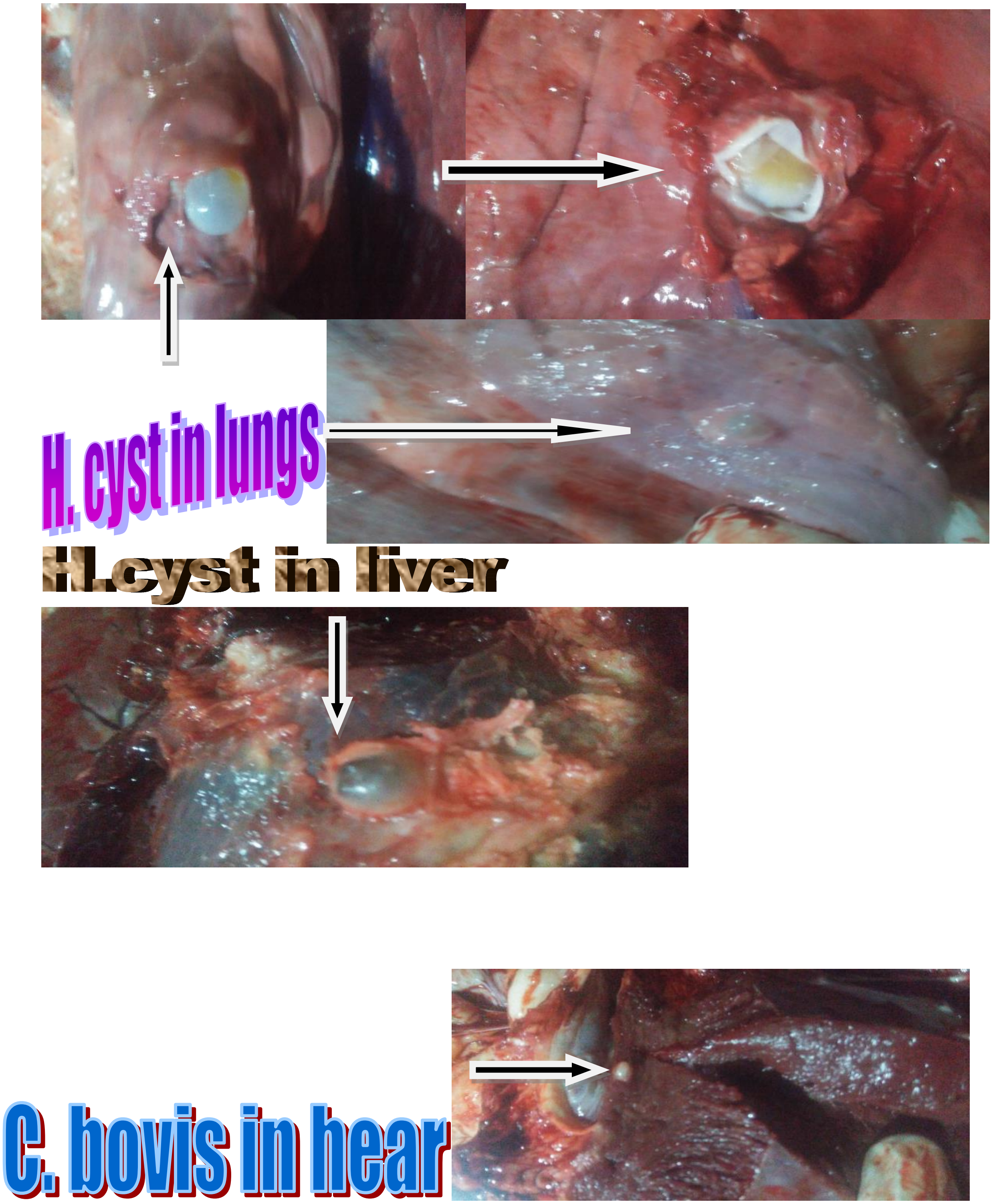
Cysticercosis:

9. Cysts which was found at meat inspection was removed with the surrounding tissue
10. Take the cysts to laboratory in cool box.
11. Remove the tissue from the cyst and aspirate the fluid from the cyst by a sterile 18 gauge needle and transfer to a test tube.
12. Placing the cyst in anormal saline solution with 40% ox bile and incubate at 37^{o}c for 1 to 2 hours in incubators.
13. Confirm the viability of the cyst by microscope examination of sediment protoscoliices.
14. A drop of sediment contained protoscolices on microscopic glass slide and cover with the cover slip; with high power objective with the principle that a cyst was viable if the scolex is evaginated during this period (Gracey, 1999).

8. 9. Antemortem and postmortem abattoir recording format

Ser No	Date	Antemortem records							Postmortem inspection records								
		Code	Spp	Breed	Sex	Age	Bcs	Season	*C.bovis* *Diagnosis*		*E. granulosus* *diagnosis*		Cyst characterization				
									+ve/ -ve	Organ/ muscle	+ve/ -ve	Organ/ muscle	Cyst size	Cyst fertility			
														Fertile		Unfertile	
														Viable	Non-viable	Sterile	Calcified

8. 10. Gross necropsy lesions of H. cysts and *C. bovis* in lung, liver and heart of abattoir slaughtered animals



9. BIOGRAPHICAL SKETCH

The author, Dr. Dawit Akeberegn Ababu, was born at Merhabete Woreda, North Shoa Zone of Amhara Region on 11th December 1987 from his mother Kebedech Gessesse and his father Akeberegn Ababu. I attended my elemantary and high school education at Alemketema elementary School and Arbegnoch Senior Secondary School, respectively in Merhabete Woreda, and preparatory school at Haile Mariam Mamo preparatory school in Debre Berhan. I succeeded in the national examination and joined Gondar University in September 2005 and graduated in July 2010 with Doctor of Veterinary Medicine (DVM).

Soon after graduation, I worked in different organizations for about 9 years. I employed by Tesfu Bekele private Veterinary Drug Shop at Deneba Woreda, North Shoa from July 2010 to October 2010. I worked as a field veterinarian in Agricultural and Rural Development office of Gisherabel Woreda, North Shoa from October 2010 to March 2013. I worked in Debre Berhan Sheep Multiplication and Breed Improvement Centre as farm veterinarian from April 2013 to November 2014, and from November 2014 todate, I am working at Debre Berhan Municipality office as senior meat inspector being based in Debre Berhan town, North Shoa Administrative Zone in Amhara Region.

Then after, I re-joined the School of Graduate Studies of Debre Berhan University in 2018 to pursue my MSc in Animal Production. I completed my graduate studies in 2020 and awarded an MSc degree in Animal Production. I am currently a member of Ethiopian Veterinarian Association (EVA).