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METACESTODES OF SMALLRUMINANTS: PREVALENCE AT THREE EXPORT ABATTOIRS (ELFORA, Hashim & Luna)

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A thesis submitted to the School of Graduate Studies of Addis Ababa University in partial fulfillment for the requirements for the Degree of Master of Science in Tropical Veterinary Medicine

By

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Board of Examiners Signature

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LIST OF ABBREVIATIONS

ABZ	Albendazole
AE	Alveolar Echinococcosis
CE	Cystic Echinococcosis
CDC	Center For Disease Control
CNS	Central Nervous System
CSA	Central Statistical Authority
CIRAD	Centre de Cooperation Internationale en Recherche Agronomique pour le evelopment
CTA	Technical Center for Agricultural and Rural Cooperation
CT	Computed (computer assisted) Tomography
DNA	Deoxyribonucelic Acid
ELISA	Enzyme-Linked Immunosorbent Assay
FAO	Food and Agriculture Organization of the United Nations
ILRI	Intrenational Livestock Research Institute
OIE	Office Internationale des Epizooties (World Organisation for Animal Health)
PAIR	Puncture, Aspiration, Injection, Reaspiration
US	Ultrasonography
WHO	World Health Organization
X-ray	Radiography
°C	Degree Celsius

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ABSTRACT

A study to determine the prevalence of small ruminants' metacestodes was conducted in three export abattoirs (ELFORA, Hashim and Luna). In an attempt to find out the prevalence of the metacestodes (*Cysticercus tenuicollis, Cysticercus ovis* and hydatid cyst) in sheep and goats slaughtered at the three export abattoirs, a total of 1476 sheep and goats (246 from each species at each abattoir) were randomly sampled and examined after slaughter for the presence of these metacetodes in the carcasses, organs and viscera of the animals using the standard meat inspection procedures. Positive or suspected samples were taken to the parasitology laboratory at the Faculty of Veterinary Medicince, Debre Zeit and cyst identification, fertility and viability tests were performed. To determine the prevalence of the metacestode, *C. cerebralis*, a total of 450 of sheep and goats (75 from each species at each abattoir) were randomly selected, after slaughter the heads opened, brains exposed and examined for the presence of the *Coenurus cerebralis*. The results of the study revealed that the overall prevalence of the four metacestodes; *C. tenuicollis*, *C. ovis*, hydatid cyst and *C. cerebralis* in the study abattoirs were 32.7%, 1.4%, 2.4%, 2.2% in sheep and 34.7%, 0.3%, 2.7%, and 12.4% in goats respectively. The occurrence of *C. ovis* in small ruminants found in this study is the first documented and confirmed report in this country. The results also revealed that *C. cerebralis* is prevalent in small ruminants of lowland and midland areas in this country. The prevalence of *C. cerebralis* recorded in goats in the study is also the first documented report in the country. The age prevalence of *C. tenuicollis* by age was found to be higher in animals with the age above 3 years, 37.8 % and 47.2 % in sheep and goats respectively. The differences in prevalence between the age groups were statistically significant ($P<0.05$). As to the distribution of cysts in the organs or viscera of infected animals, in majority of the animals harbouring *C. tenuicollis*, the cysts showed more tendency to be located in the omentum and mesentery than in the peritoneum and liver and this difference was significant ($p<0.05$). The prevalence of hydatid cysts among the three age categories of the sheep and goats showed increment as the age of animals increased and hence there was slight positive correlation between age of sheep and goats and infection rate ($r = 0.07$). The distribution of cysts in the internal organs showed significant variation between the two organs, lungs and liver in both animal species ($P < 0.001$). All recovered cysts except three were located in lungs in both sheep and goats. Among the 37 animals (18 sheep and 19 goats) harbouring hydatid cysts, 16 of the 18 sheep (88.9%) and 18 of the 19 goats (94.7%) had cysts in their lungs while only in 3

animals (2 sheep and 1 goat) the cysts were located in liver. Out of the 118 hydatid cysts recovered, 58 (49.15%) were fertile while 60 (50.85%) cysts were sterile (unfertile) in both species. The prevalence of *C. ovis* among the examined three age groups of animals (0.5 to 2 years, >2 to 3 years and above three years) was analysed. The result revealed that only animals belonging to the first age group in both sheep and goats were found to harbour *C. ovis* in cardiac muscle and diaphragm. The age wise prevalence of *C. cerebralis* showed that the highest infection rate (5.3% and 25.3%) was observed in the youngest age group in sheep and goats respectively, whereas the lowest rate (1.3%) in goats was found in oldest age group, the differences were statistically significant ($p<0.001$). Of the four metacestodes, the prevalence of *C.tenuicollis* was the highest and the most important cause of liver condemnation with consequent economic loss in the three export abattoirs. The results found in this survey showed that metacestodes pose significant economic problem in the export abattoirs practicing the slaughter of small ruminants and export meat of these animals by causing condemnation of considerable numbers of livers of these animals, rendering them unfit for export market. Therefore, initiation and implementation of control measures become necessary in order to alleviate the risk to export market as well as zoonotic risks to the human population residing in the vicinity of the export abattoirs due to improper disposal of abattoir materials being practiced presently.

Keywords: *Coenurus cerebralis*, *Cysticercus ovis*, *Cysticercus tenuicollis*, Export abattoirs Hydatid cyst, Metacestodes, Prevalence, Small ruminants.

1. INTRODUCTION

Small ruminants provide more than 30 % of local meat consumption and generate cash income from export of meat, live animals, and skins. An increase in small ruminants' production is needed both to maintain self-sufficiency in meat and to increase export earnings (Ibrahim, 1998). Among the serious constraints of small ruminants' production, parasitism ranks high. It is well established that parasitized animals perform less efficiently, food conversion is adversely affected; carcass quality is reduced, wool yield declines and consequent economic losses are significant (Morris, 1988; Troncy, 1989).

Cestodes of the family Taeniidae which infect the dog (definitive host) are transmitted to a range of intermediate host species where they cause echinococcosis/hydatidosis, cysticercosis or coenurosis. Infections with the larval stage of some species of *Taenia* are of veterinary importance because they cause economic losses due to condemnation of infected offal or meat (Flisser et al., 1982; Eckert et al., 2001; Thompson, 1995). Dogs and wild canids are the definitive hosts of metacestodes of sheep, goats and other ruminants, which occur throughout most of the world (Soulsby, 1982).

Metacestodes are infective larval stages of *Taenia* species which occur in the body of intermediate hosts, sheep and goats and they prevail throughout most of the world. Diseases associated with metacestodes in small ruminants include: cysticercosis (muscular & visceral), hydatidosis, Coenurosis (Gid), which are caused by the presence of the larval stages: *Cysticercus ovis, Cysticercus tenuicollis,* Hydatid cyst and *Coenurus cerebralis respectively.*

Infestation of small ruminants with metacestodes is responsible for condemnation of large quantity of viscera / organs and muscles during meat inspection with considerable economic losses (Sanyal and Sinha, 1983; Oryan *et al.*, 1993).

The larval forms of *Taenia ovis (Cysticercus ovis)* cause muscular cysticercosis, or "sheep measles", in sheep and goats in many countries *C. ovis*, being found in the muscles of sheep and goats, is primarily important because of aesthetic objections to the appearance of the cysts in

sheep meat and in consequence, it can be a significant cause of economic loss through condemnation at meat inspection especially in mutton exporting countries (Arundel, 1972).

Cysticercus tenuicollis, a metacestode of *Taenia hydatigena*, invades the liver and abdominal cavity of the intermediate hosts; sheep, goats, other ruminants and pig causing considerable tissue damage during larval migration. Fibrous scars resulting from the migration of the larvae lead to condemnation of the viscera and disposal of other offals to which the mature bladder worms attach. Infected animals do not show any clinical signs and the economic impact is measurable only in terms of the condemned organs. The cysticerci of Taenia hydatigena are responsible for a high degree of morbidity and mortality in livestock (Abidi *et al.*, 1989).

The larval stage of the cestode parasite *Echinococcus granulosus* causes cystic hydatid disease, which affects humans and a range of livestock animals. E. granulosus has a cosmopolitan distribution. Hydatid disease is a serious health concern in sheep and goats rearing regions of the world. Cystic echinococcosis (CE) is highly endemic among the nomadic pastoral tribes of East Africa, but is rare amongst the agriculturally based communities. Echinococcus granulosus infections are common in dogs from all countries in sub-Saharan Africa where they have been examined (Magambo *et al*., 2005).

The larval form of *Taenia multiceps* (*Coenurus cerebralis)* develop in the brain of sheep and goats resulting in a chronic neurological disorder known as gid or staggers. *Coenurus cerebralis* infection has been observed as a common and worldwide problem of small ruminants. Dog being definitive host of *Taenia multiceps* plays an important role in spreading the disease. Occurrence of coenurus cysts in brain, spinal cord and in other tissues has been noticed in wide range of animals like sheep, goats, cattle, horse, buffalo, camel and yak including some wild animals (Sharma and Chauhan, 2005).

Reports regarding the prevalence of some of the metacestodes of small ruminants in Ethiopia in different abattoirs have been made by some investigators. According to these reports, the hydatid cyst is the most common metacestode encountered followed by *C. tenucoillis* and only few reports of *Coenurus cerebralis* in high land sheep. No official report has been made with regards to the presence or absence of *Cysticercus ovis* in small ruminants. So far most of the studies that have been done on metacestodes in the abattoirs of this country mainly have focused on cattle.

Threfore, much remains to be done on metacestodes especially in small ruminants slaughtered at export abattoirs for the export of meat of these animals.

Currently, some modern export abattoirs are established and have started exporting sheep and goat meat to Middle East countries and this export market is highly promising and is enabling the earning of foreign currency, which is highly needed by the country. Such export market may be influenced by the quality of meat produced especially from diseases point of view. Some of metacestodes which occur in the carcass and organs of small ruminants can affect the small ruminants' meat export market either directly or indirectly by causing rejection of carcass/organs for aesthetic reasons by the importer countries or due to condemnation of organs such as liver and heart which have highly demanded by importers.

Based on this it was considered necessary to the under take a study on the prevalence and significances of metacestodes in small ruminants which are slaughtered for export purpose at newly emerging export abattoirs so as to know the status in these abattoirs and implement appropriate control measures which may ensure the sustainability of foreign market to the meat of sheep & goats as the export market is highly sensitive to diseases especially those which are important from meat hygiene (aesthetic) and zoonotic point of view.

Therefore, the objectives of this study were:

- To determine the prevalence of Metacestodes of small ruminants at three export abattoirs (Elfora, Hashim & Luna).
- To identify the important metacestode causing organ condemnation at the study abattoirs.

2. LITERATURE REVIEW ON METACESTODES OF SMALL RUMINANTS

2.1. General Description of Cestodes and Metacestodes

2.1.1. Morphological Identification

Adult tapeworms are dorsoventrally flattened, segmented and large, reaching from several centimeters to several meters. A tapeworm consists of scolex, neck and strobilla. Anteriorly, the scolex (head) has four muscular suckers and may have a rostellum, often armed with two rows of hooks, the length and number of these hooks being relatively characteristic of a species. A neck follows the scolex, and this is followed by immature and then by mature reproductive segments, and finally gravid segments filled with eggs. Metacestodes of *Taenia spp* consist of a fluid-filled bladder with one or more invaginated protoscoleces. These 'bladderworms' are each contained within a cyst wall at the parasite–host interface. This structure comprises the *cysticercus* or *coenurus* (Soulsby, 1982; Urqurt *et al*., 1996).

2. 2. Morphology of the Adult Parasites

2.2.1. *Taenia hydatigena*

Adults are 75–500 cm long and are found in the intestine of dogs and wild carnivores, and have an armed rostellum with two rows of 26 and 46 rostellar hooks (Soulsby, 1982).

2.2.2. *Taenia ovis*

Adult worms live in the intestine of dogs and wild carnivores reach 1–2 metres in length and have an armed rostellum. The scolex bears 4 suckers and 2 rows of hooks; proglottids have one lateral genital pore each. The utrerus has 11-20 lateral branches. The eggs are brown, oval with a hexacanth embryo and have thick, radially striated shell and 19-31 by 24-26 μm in diameter (Smyth, 1994; Soulsby, 1982).

2.2.3. *Taenia multiceps*

Adults are 40–100 cm long in the intestine of carnivores and have an armed rostellum. Scolex is pear-shaped and has two rows of 22 to 30 hooks on the rostellum.Gravid segments are 8 to 10 mm long by 3 to 4 mm wide. The uterus has 14 to 20 lateral branches, and eggs are 29 to 37μm in diamerter (Soulsby, 1982; OIE, 2004).

2.2.4. *Echinococcus granulosus*

This is the smallest of all tapeworms (3 to 9 mm long) with only 3 proglottids. The adult *E. granulosus* is only a few millimeters long, varying between 2-7 mm in length with 3 segments (Soulsby; 1982; Eckert and Deplazes, 2004; OIE, 2004). Anteriorly, the adult parasites possess a scolex, which has four muscular suckers and two rows of sickle shaped hooks, one large and one small, on the rostellum. The mean length of the large hook ranges from 22-49 μm, and that of the small hook ranges from 17-39 μm (Thompson and Lymbery, 1988; OIE, 2004). The adult worm is hermaphrodite. The body or strobila has a number of reproductive units (proglottids) (Smyth, 1994), the mature penultimate proglottid and the terminal proglottid. The latter is gravid and is usually more than half the length of the worm (Soulsby, 1982). This gravid proglottid/uterus has 12-15 short lateral diverticuli and, is usually filled with 100-1500 thick-shelled eggs (Thompson, 1995). The gravid proglottids and or eggs are shed in the faeces (McManus *et al.*, 2003). The eggs are brown in colour and morphologically indistinguishable from those of other tapeworms of the genus *Taenia* (Smyth, 1994). The size of the eggs ranges from 30-40 μm and they have a thick radially striated shell. The egg has a single hexacanth embryo, the oncosphere, which has three pairs of hooks (Thompson and McManus, 2001).

Figure 1. Adult Echinococcus granulosus (Arcari *et al.*, 2005).

2.3. Morphology of the larval stages (metacestodes)

2.3.1. *Cysticercus tenuicollis*

Metacestodes are large, from 1 cm up to 6–7 cm, and the scolex has a long neck. They are found attached to the omentum, mesentery and occasionally on the liver surface, particularly of sheep and goats but also of other domesticated and wild ruminants and pigs (OIE, 2004).

2.3.2. *Cysticercus ovis*

Cysticerci are clear, translucent, pearly white or white. They are usually round to ovoid and approximately 1 cm or less in diameter; each fluid-filled vesicle contains a single invaginated protoscolex, which usually appears as a single dense white body. An organ may contain one to hundreds of cysticerci. Cysticerci in various stages of viability can occur simultaneously in a host. Degeneration is associated with increasing opacity of the cyst wall. The fluid thickens and the cyst eventually becomes filled with greenish or yellow, caseous material. Inactive larvae may be calcified (OIE, 2005).

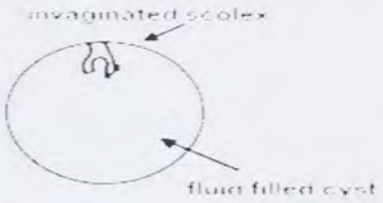

Figure 2. The structure of Cysticercus (Urquhart et al., 1996)

2.3.3. *Coenurus cerebralis*

The metacestodes are coenuri – large, white fluid-filled cysts that have up to several hundred scoleces invaginated on the wall in clusters. These grow to 5 cm or so 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 (OIE, 2004).

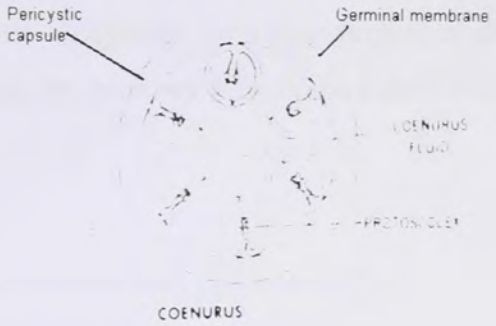

Figure 3. Structure of Coenurus (Urquhart, *et al.*, 1996).

2.3.4. The Hydatid cyst

The metacestode, hydatid cyst basically consists of a bladder with an outer acellular laminated layer and an inner nucleated germinal layer, which may give rise by asexual budding to brood capsules. Protoscoleces arise from the inner wall of the brood capsules. If the scolices separate from the inner lining of the capsule, they are called hydatid sand.The structure and development of the metacestode differs between the four species of Echinococcus. (Soulsby, 1982; Urquhart *et al.*, 1996, WHO/OIE, 2001).

rate and poor prognosis if managed inappropriately. Hydatid cysts of *E. granulosus* develop in internal organs (mainly the liver and lungs) of humans and intermediate hosts (herbivores such as sheep, horses, cattle, pigs, goats and camels) as unilocular fluid-filled bladders. These consist of two parasite-derived layers; an inner nucleated germinal layer and an outer acellular laminated layer surrounded by a host-produced fibrous capsule. Brood capsules and protoscoleces bud off from the germinal membrane (Thompson and McManus, 2001).

2.3. Biology and epidemiology

2.3.1. Life cycle of *T. hydatigena*

The adult tapeworms live in the small intestines of dogs and other carnivores; segments containing numerous eggs are passed in the faeces. After disintegration of the segments, eggs can be disseminated by wind and by insects contaminating the pasture. Ingesting eggs then infects ruminants. The embryos penetrate the wall of the digestive tract and migrate to the liver, where they migrate through the liver surface to enter the abdominal cavity. The fully developed cyst is a large (5 cm or more in diameter), soft, semi-transparent bladder within which the invaginated head of the tapeworm is clearly visible. The final host is infected by ingesting the cysts (Jorgen and Brian, 1994). Figure 5 shows the life cycle of *T. hydatigena*.

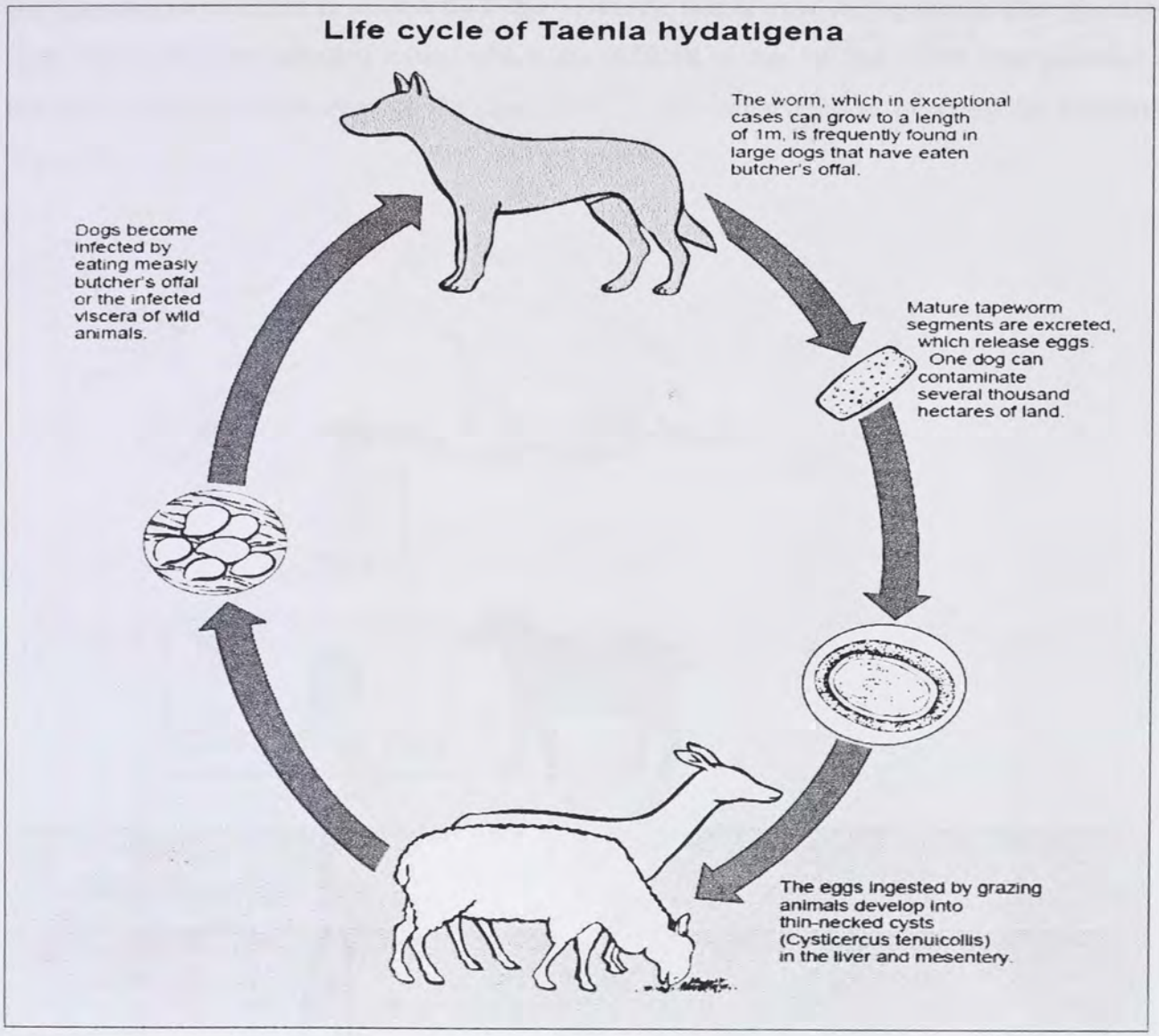

Figure 5 Life cycle of *T. hydatigena* (Bayer, 2001).

2.3.2. Life cycle of *T. ovis*

Dogs become infected with *T. ovis* worms by eating raw sheep/goat meat or offal infected with *C. ovis* cysts. These cysts develop to adult worms in dog's intestine after four to five weeks. Mature worms shed eggs via the dogs' faeces in large numbers (up to 250,000 per day). Eggs have the ability to survive on pastures for up to six months depending on conditions. Sheep become infected with *C. ovis* cysts by ingesting eggs shed by dogs onto pastures. The sheep's digestive juices dissolve the egg's shell and release an embryo, which burrows through the intestinal wall

and into the blood stream to eventually lodge in muscle tissue. Four to five weeks after ingesting eggs, sheep develop infective cysts, which are difficult to see or feel. Each cyst contains a tapeworm head, which develops to the adult worm, *T. ovis* when ingested by a dog, the final host (figure 6).

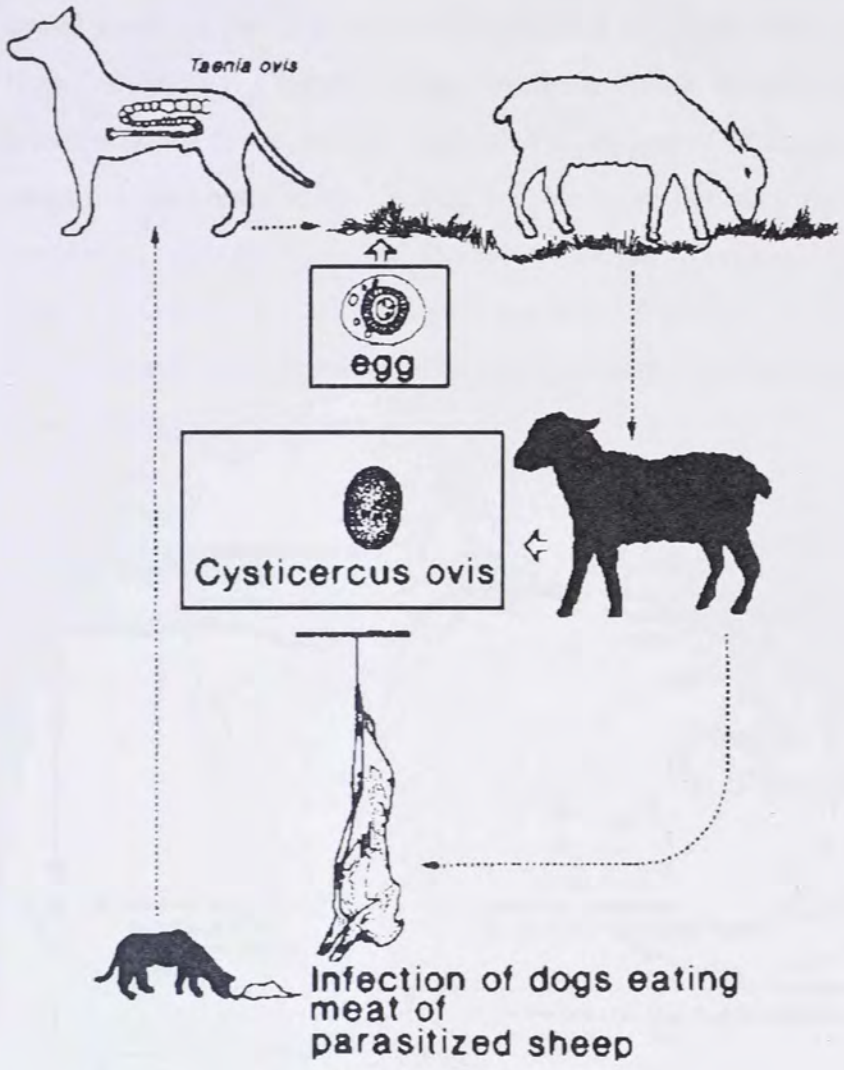

Figure 6. Life cycles of *T. ovis* (Jorgen and Brian, 1994).

2.3.3. Life cycle of *Taenia multiceps*

Sheep and goats, the intermediate hosts for *T. multiceps*, are infected by ingestion of the taenia egg/oncosphere while grazing on an infected pasture by the feces of dogs. The egg hatches in the small intestine and the coenurus burrows through the intestinal wall and travels to the brain and spinal cord via the bloodstream (Urquhart et al., 1996). The coenurus typically develops in the brain, reaching the infective stage in about 6 to 8 months. When dogs or other canids ingest infected sheep tissue, usually through the feeding of offal, the protoscolices attach to the small intestinal wall and the worms begin to form proglottids (one of the segments of the tapeworm containing both the male and female reproductive organs). Proglottids containing eggs detach from the end of the worm and pass out in the feces and the cycle repeats (Soulsby, 1982). The larval form may rarely infect man, where it causes cerebral coenurosis on accidental ingestion of tapeworm eggs in the feces (figure 7).

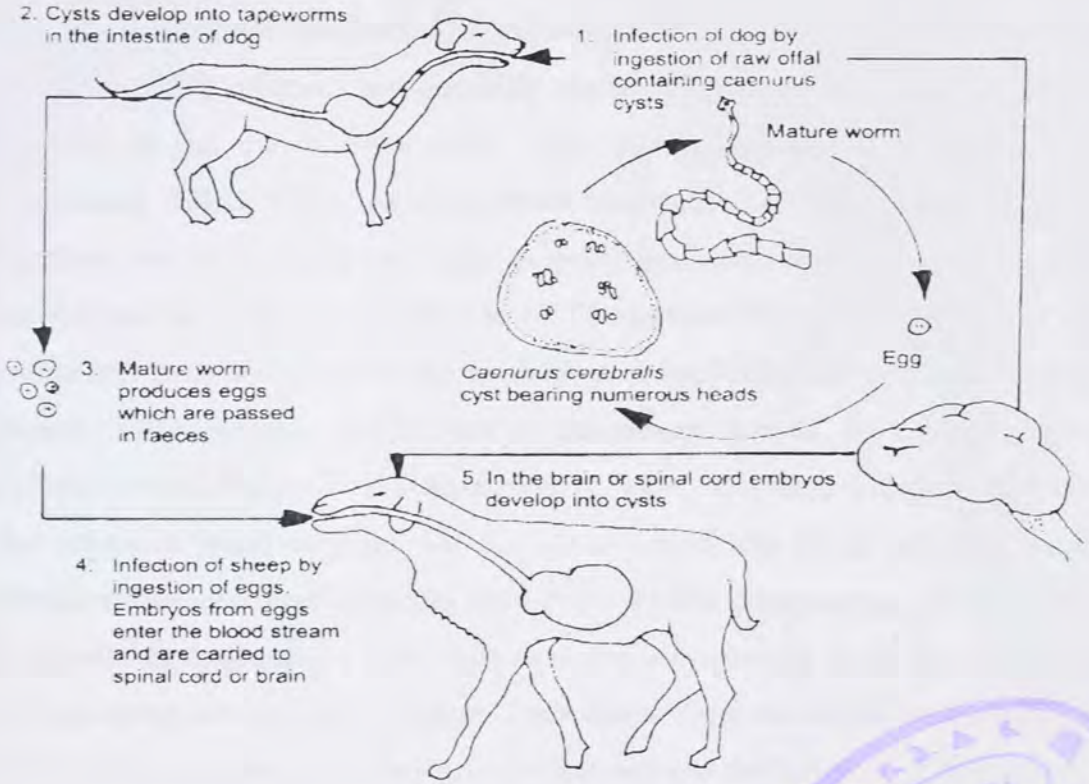

Figure 7. The life cycle of *Taenia multiceps* (Ibrahim, 1998)

2.3.4. Life cycle of *E. granulosus*

E. granulosus is an obligatory heterogeneous parasite with a complex life cycle.It requires two mammalian hosts to complete its life cycle. This involves the definitive hosts (domestic dogs and wild canids) and the intermediate hosts (domestic and wild ungulates, humans) (OIE, 2004). The definitive host is infected by ingestion of offals containing fertile hydatid cysts (i.e. cysts with viable protoscolices). The protoscolices evaginate and attach to the intestinal mucosa and develop into adult stages (McManus et al., 2003). The pre-patent eriod of E. granulosus in the definitive host ranges from 34-58 days (Thompson, 1995). The adult worm passes out gravid proglottids containing eggs, or free eggs are passed out with the faeces. These gravid proglottids, or eggs, are dispersed and contaminate the environment, feed, grass or water, etc, which are sources of infection to many intermediate hosts, including humans, over a wide area (Soulsby, 1982; Gemmell *et a*l., 2001; Thompson, 1995). The infective eggs in grass feed or in water are ingested by the intermediate hosts and hatch into oncospheres (larvae) inside the stomach and intestines. The liberated larvae penetrate the small intestine and reach their final localization passing through vascular and lymphatic systems to the liver and lungs.They rarely spread to other organs (Soulsby, 1982). Humans are normally accidental intermediate hosts because they are rarely involved in the transmission cycle. They can be considered as ecological aberrant hosts (Torgerson, 2002). Once the oncosphere has reached its final location (liver and lungs), it develops into the metacestode stage (primary cyst). The time for development of the cysts is variable and may take several months (6-12 months) (Thompson, 1995). The developed cyst is unilocular, thick-walled, spherical in shape and fluid-filled. Its size ranges from 2 to 30 cm in diameter. But, in areas where there is unrestricted growth, the cyst may be very large and contains several liters of fluid (Urquhart et al., 1996). It is lined with an inner germinal membrane that produces brood capsules. On the inner wall of the brood capsules, an asexual budding process of protoscolices enhances the infectivity and compensates for low sexual reproduction that produces thousands of protoscolices within a single cyst. Each single protoscolex is capable of developing into a sexually mature adult worm. Once the definitive hosts consume the organs with fertile and viable cysts they become infected and the life cycle is completed (Thompson and McManus, 2001). The metacestode of E. multilocularis cysts are located exclusively in the liver and are not enveloped by host connective tissue. Therefore, it occurs as cancer-like growths in the liver parenchyma of intermediate hosts (mainly rodents and aberrant host animals and humans)

(Eckert and Deplazes, 2004). Transmission of *E. granulosus* to humans is affected by such factors as prevalence of the parasite in domestic dogs, behaviors of humans towards dogs, and heterogenicity of the parasite and susceptibility of humans to infection. Sheep and goats appear to be the most common domestic intermediate hosts, but recent studies suggest that camels are equally important intermediate host. The life cycle of *E. granulosus* is shown in figure 8.

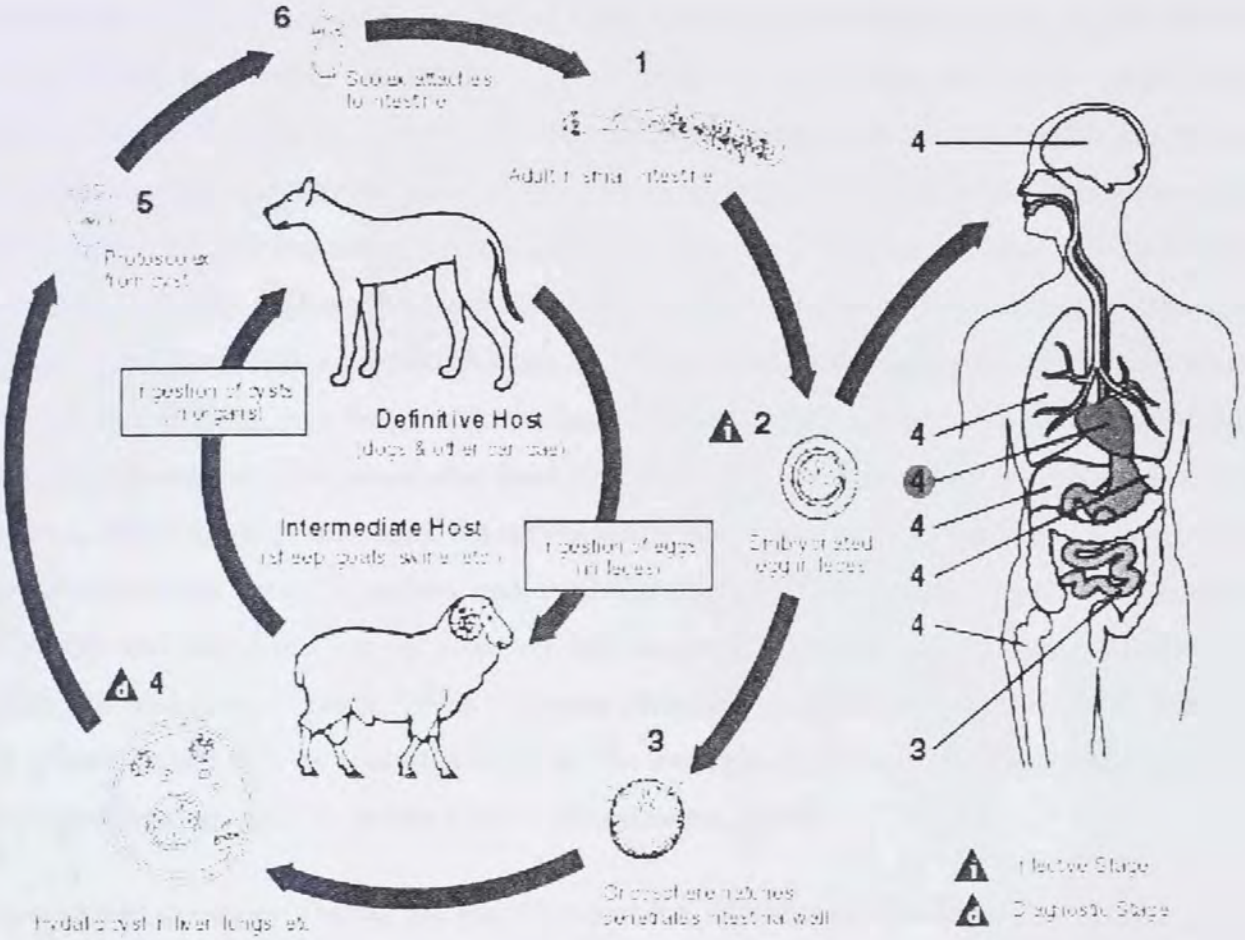

Figure 8 Life cycle of *E. granulosus* (CDC, 2003).

2.3.5. Epidemiological considerations

Metacestodes of small ruminants are widely prevalent all over the world. The success of the different larval stages is dependent upon the presence of suitable final host and their relation ship with the intermediate host. Access to infective eggs/oncospheres/ is essential in establishing infection in the intermediate host. Like wise, access to metacestodes by the final host is essential in establishing infection and maintaining the life cycle (Craig *et al.*, 1996).

The life cycles of *E. granulosus* strains can be classified as domestic/pastoral/, involving the domestic dog as the principal definitive host and various species of domestic ungulates as intermediate hosts, or as sylvatic, involving wild carnivores and ungulates as hosts (the wildlife cycle). Within the cycles, the specific role of various host species may differ considerably between regions of endemic infection. In many areas of endemic infection, domestic and sylvatic life cycles coexist or overlap (Rausch, 1995). For example, the dog-sheep strain is globally the most widespread and important strain of *E. granulosus* and exists in its domestic form (dog-sheep/goat) in many regions. However, in Australia this strain is transmitted between domestic animals (dog/sheep) and wild-animal hosts (definitive hosts are dingoes [*Canis lupus*], dingo-domestic dog hybrids, less frequently red foxes [*Vulpes vulpes*]; intermediate hosts are mainly *Macropod marsupials* (kangaroo) also feral pigs [*Sus scrofa*] and wombats [*Vombatus ursinus*]) (Jenkins, 2002). On the other hand, the cervid strain of *E. granulosus* in the Arctic is transmitted almost exclusively between wolves and wild Cervidae, elk [*Alces alces*], reindeer [*Rangifer tarandus*], and red deer [*Cervus elaphus*] but domestic dogs and domesticated reindeer can replace the wild hosts (Rausch, 1995). Complex situations of coexisting or overlapping domestic and sylvatic cycles also exist in other regions (for example, in Africa and Eurasia) and represent special problems in echinococcosis control (Macpherson, 2001).

Transmission dynamics: During the past four decades, considerable advances have been made in understanding the epidemiological key factors and the transmission dynamics of *E. granulosus* and other members of the family Taeniidae (notably *Taenia hydatigena* and *T. ovis*). A mathematical model was developed which allows us to quantify various factors contributing to the regulation and stability of the parasite populations and to draw conclusions for control (Roberts et al., 1987; Togerson, *et al.*, 1998; Torgerson, 2002).

For *Taenia* species, the following key factors have been identified (Craig *et al.*, 1996; Gemmell *et al.*, 2001): - (i) biotic potential of the parasite, (ii) immunity acquired by the intermediate host as a density-dependent constraint, and (iii) environmental factors as density-independent constraints in the free-living egg-phase. *T. hydatigena* and *T. ovis* have high biotic potentials with the production of large numbers of eggs and large numbers of metacestode cysts developing in sheep. In contrast, the biotic potential of *E. granulosus* is relatively low, representing less than 5% of the potentials of *T. hydatigena* and *T. ovis*. Results of previous studies have suggested that the degree of immunity acquired by definitive hosts during natural infections with *E. granulosus* is negligible and does not play a role in regulating the intestinal parasite population (Gemmell and Roberts, 1998).

On the other hand, acquired immunity in intermediate hosts has clearly been identified as a density-dependent constraint reducing the parasite (metacestode) population of *Taenia* species. A considerable degree of immunity against *T. hydatigena* and *T. ovis* is acquired by sheep within about 2 weeks after ingestion of small numbers of eggs (as few as 10 eggs per animal); it persists life-long in the presence of eggs in the environment but is lost between 6 and 12 months in the absence of eggs, and it does not depend on the presence of metacestodes from a previous infection (Gemmell, and Roberts1998). Strong immunity can also be experimentally induced against *E. granulosus*, but it requires much larger numbers of eggs (approximately 50,000 eggs per animal). Consequently, sheep populations do not develop strong immunity against *E. granulosus* under natural infection pressure, as indicated by the fact that both the prevalence and intensity of the infection with cysts of *E. granulosus* increase with age of sheep.

2.4. Importance of small ruminant metacestodes

2.4.1. Clinical / pathogenic importance

Despite the widespread occurrence of metacestodes in small ruminants and occupying different sites of the internal body, their pathogenic effect except for some stages is of little significance. The effects of hydatid cysts depend on the organs in which they are situated and the number of cysts present. It is generally considered that hydatid infections of ruminants are not clinically important and disease due to the presence of hydatid cysts in ruminants is rare. Occasionally

numerous large cysts may cause respiratory problems when they are situated in the lungs; digestive disturbances and ascites may be seen associated with heavy infections of the liver (Jorgen and Brian, 1994).

Severe infections with cysticerci of *T. hydatigena* may occasionally kill the host but generally damage to the viscera is confined to the liver, and has little significance to the overall health of the host. The developed *C. tenuicollis* has no pathogenic effect while situated in the abdominal cavity. When many embryos migrate simultaneously through the liver clinical signs may be seen. The migration may cause severe destruction of liver tissue and the pathology seen in the liver may be similar to that observed in liver fluke infections (Jorgen and Brian 1994). Heavy infestation with *Cysticercus tenuicollis* in young animals causes liver damage and hemorrhages or peritonitis can rarely results in the death of the animal. A serious condition known as "hepatitis cysticercosa" caused by *C. tenuicollis* in different animals was described by many workers (Soulsby, 1982; Pathak *et al*., 1982). A similar condition known as "pnemonitis cysticercosa" in lungs of goats was reported due to *C. tenucollis* (Deodhar and Narsapur, 1964; Soulsby, 1982). There are few pathological changes that occur with a *T. hydatigena* cysticerci infection, but severe infections can be hazardous to the animal's health. Cysts, varying in number from 1 to 75, can be present in the omenta and in the mesenteries. In extremely heavy infections the viscera may become knotted together and organ function may be impaired. Degenerate cysts are replaced by caseous and calcareous debris and may damage tissue. Meandering streaks may be present in the liver due to larval parasite migration. If large numbers of larvae migrate through the liver parenchyma, tissue will be damaged and acute and fatal hepatitis may be the result (Pathak *et al*, 1982).

Coenurosis due to larval stage of *T. multiceps* can occur in both an acute and a chronic disease form. Acute coenurosis occurs during the migratory phase of the disease, usually about 10 days after the ingestion of large numbers of tapeworm eggs. Young lambs aged 6-8 weeks are most likely to show signs of acute disease. The signs are associated with an inflammatory and allergic reaction. There is transient pyrexia, and relatively mild neurological signs such as listlessness and a slight head aversion. Occasionally the signs are more severe and the animal may develop encephalitis, convulse and die within 4 - 5 days (Skerritt and Stallbaumer, 1984 Skerritt, 1991).

Chronic coenurosis typically occurs in sheep of 16-18 months of age. The time taken for the larvae to hatch, migrate and grow large enough to present nervous dysfunction varies from 2 to 6 months. The earliest signs are often behavioral, with the affected animal tending to stand apart from the flock and react slowly to external stimuli. As the cyst grows, the clinical signs progress to depression, unilateral blindness, circling, altered head position, incoordination, paralysis and recumbency. Localization in the CNS of sheep causes the "staggers". Unless treated surgically, the animal will die after recumbency (Tigari *et al.*, 1987).

2.4.2. Economic importance

Economic losses from metacestodes in livestock results from condemnation of carcasses or offal as unsuitable for human consumption at the abattoirs.

Cysticercus ovis: - Detection of *C. ovis* cysts in muscles of sheep and goats usually results in condemnation of the meat for aesthetic reasons with consequent economic losses (Urquhart *et al.*, 1996).

Cysticercus tenuicollis: - Fibrous scars resulting from the migration of the larvae lead to condemnation of the viscera and disposal of other offal to which the mature bladder worms attach. There is no human health hazard, but the liver lesions are unsightly and affect the texture of the tissue, making it unsuitable for human consumption and the economic losses associated with condemnation of affected organs are significantly high (Hall, 1985).

Hydatid cyst: - Cystic echinococcosis in farm animals causes considerable economic problems due to loss of the edible organs such as liver. Significant loss of meat and milk production and value of the fleece from infected sheep may also occur. These losses are of especial significance in countries of low economic output where sheep and goat production is of particular importance (Torgerson, 2002). Production-based losses attributable to infected sheep goats are estimated based on losses from liver condemnation, defined as the action of preventing the sale of livers deemed unfit for human consumption, reduction in carcass weight, decrease in hide value, decrease in milk production and decreased fecundity were taken into account. Losses from liver condemnation are assumed to occur since hepatic pathology is associated with infection (Budke *et al.*, 2006).

Coenurus cerebralis: - An economic loss from this parasite occurs when valuable breeding stock become affected with gid and has to be killed or surgically treated to remove the parasite (Karim, 1979). Mortality to the extent of 5% in sheep due to coenurosis has been reported (Njau *et al.*, 1988) from Ethiopian highland. Achenef *et al.* (1999) have quoted from unpublished data from the sheep breeding and improvement Station at Debre Berhan, Ethiopia that coenurosis accounted for 37.4% of culling of improved stock. Similarly, Abo-Shehada *et al.* (2002) also observed coenurosis an important cause of sheep culling in Jordan. Oryan *et al.* (1994) from Far Province of Iran, described losses resulted from condemnation of meat and viscera due to metacestodes to the extent of US$ 2.6 million.

2.4.3. Zoonotic importance

2.4.3.1. Hydatid cyst

The major significance of cystic and alveolar echinococcsis is the risk of human infection. In humans, hydatid cysts can establish in the brain, kidneys, bone, liver and other tissues. Hydatid cysts growing in the body cause the disease. Clinical signs can take months to years to develop and become more apparent as the cysts grow. As the cysts increase in size they can cause the body to become distended. When the cysts grow in vital organs, they may disrupt the function and lead to signs of disorders related to disruption of the organ functions. The most serious development is when the cyst ruptures and causes an anaphylactic reaction, which may be fatal (Thompson and Allsop, 1988).

2.4.3.2. Coenurus cerebralis

Coenurosis is a relatively unusual zoonotic disease of humans, caused by the larval stage (coenurus) of a dog tapeworm, *Taenia (Multiceps) multiceps*. *Taenia multicep has* a wide distribution in temperate areas, where it usually circulates, in a domestic cycle, between dogs and herbivores (sheep). Human infection occurs if eggs are accidentally ingested as a result of poor personal hygiene after being shed in the feces of the dog. After ingestion of the eggs, larvae hatch, penetrate the intestinal wall, and migrate to various tissues, where they develop into large, cystic larvae. Symptoms are secondary to the presence of a cyst in a vital structure. Patients with coenurosis present with headache and papilledema. The cysts have been responsible for Jacksonian epilepsy, hemiplegia, monoplegia, and cerebellar ataxia. When the spinal cord is

affected, there may be spastic paraplegia, lymphadenopathy, fever, and malaise can occur, raising the suspicion of lymphoma. Cysts are found in the liver, muscle, and brain (Sharma and Chauhan, 2005).

Cysticercus ovis and *Cysticercus tenuicollis* have no public healh significance and are of importance solely as a cause of economic loss in meat industry due to aesthetic rejection of muscle, organs or viscera (Arundel, 1972).

2.5. Diagnosis

2.5.1. In live animal

2.5.1.1. Immunodiagnosis

Cystic echinococcosis (CE) in Animals: In comparison with investigations in humans, relatively little research has been directed toward the development of immunodiagnostic techniques for *E. granulosus* infection in domesticated animals such as sheep and cattle. Currently, the diagnosis of CE in intermediate hosts is based mainly on necropsy procedures. Accurate serological diagnosis of CE infection in livestock is difficult due to serological cross-reactions with several other species of taeniid cestodes including *Taenia hydatigena* and *Taenia ovis* (Yong *et al.*, 1984; Lightowlers and Gottstein, 1995; Zahang et al., 2003). Furthermore, natural intermediate host animals produce very poor antibody responses to infection compared with the relatively high levels of specific antibody seen in human infection (Lightowlers and Gottstein, 1995). In sheep, the principal intermediate host of *E. granulosus,* in most regions of endemic infection worldwide, antibodies to various antigens including Ag5 is detectable in the sera of some but not in all infected sheep ("non-responders") (Jenkins and Rickard, 1986). As with human CE, detection of circulating antigen does not appear to be useful for diagnostic purposes (Eckert *et al*, 2001).

Coenurus cerebralis: - interpretation of clinical signs is the best method of diagnosis as serological tests are unreliable. The clinical sign also gives an indication of the location of the lesion, which is an important factor when surgical removal is economically justifiable. Radiography can reveal metacestode associated rarefaction of the skull when bone softening has

not yet reached the point of detection by digital palpation. For identification of deep parenchymal cysts, cerebral angiography has been used in goats. The angiograph reveals stagnation of contrast material around the avascular zone of the cyst surrounded by concentric arches of displaced vessel (Tigari *et al*, 1987). Computed tomography (CT) is recently used in the diagnosis of Coenurosis and allowed precise evaluation of the size and location of the cyst, which appeared as a hypoattenuating structure with a mass effect. CT imaging is a useful tool for diagnosis of ovine coenurosis since it allows accurate localization of the cyst and overcomes the difficulties of interpretation of neurological signs (Gonzalo-Orden et al., 1999).

Cysticercus tenuicollis: - because the signs are vague and not disease-specific, it is seldom diagnosed based on clinical signs alone. Similarly, the usual infection with *C. ovis* causes no signs hence diagnosis in live animals is not possible.

2.5.2. In dead/slaughtered animal

Diagnosis of *Cysticercus tenuicollis* infection is based on finding one or several cysticerci on the mesenteries or omenta during postmortem examination. Serpentine markings in the liver tissue may also be indicative of larval migration. *T. hydatigena* cysticercus identification may be confirmed by the size of the cyst and due to the presence of only one scolex in the bladder worm (Hall, 1985).

Coenurus cerebralis may be found upon necropsy in the brain of sheep and goats. The condition needs to be differentiated from other local space occupying lesions of the cranial cavity and spinal cord including abscess and tumor. Hemorrhage in the early stage of the disease may be confused with encephalitis because of the signs of brain irritation (Skkirtt and Stallbaumer, 1984).

Hydatid cysts: - Currently, the diagnosis of hydatid cyst in the intermediate hosts is based mainly on necropsy procedures and the most reliable diagnostic method is cyst detection during meat inspection or at postmortem examination.

2.6. Treatment and control approaches

2.6.1. Treatment

Today there are no effective drugs, which may be used economically in the treatment of metacestode infections in livestock. However, study work on swine cysticercosis (Gonzales *et al.*, 1996) indicated that oxfendazole may be effective in the treatment of cestodes in sheep and ultimately in humans. Erica *et al.* (1999) demonstrated that oxfendazole (30 mg/kg) was effective in the treatment of naturally infected sheep with hepatic and/or pulmonary hydatidosis.

2.6.2. Control approaches

Safe disposal of condemned abattoir offals eliminate the possibility of infection of the definitive hosts (canine species) effectively. The activities of dogs should be controlled to help prevent transmission of the parasite. Measures to stop the dog–sheep cycle include:

- To prevent infection in dogs and to interrupt the life cycle of the parasite, infected entrails (offals) should not be fed to dogs nor left available for wild carnivores.
- Preventing infected dogs from defecating on pastures grazed by sheep are important measures in lowering the incidence of the various metacestodes in sheep whose final hosts are carnivores, mainly dogs (Reincecke, 1983).
- For human protection, dogs should be kept out of vegetable plots to prevent contamination of the vegetables by eggs from the dog's faeces. Hygienic measures should also be observed (prevent dog licking hands, hand washing before heating).

Most of the attention in developing the control programme should be directed at sociocultural factors and especially the attitudes, perceptions, knowledge and desires of the community involved (WHO and OIE, 2001).

2.6.2.1. Vaccination

A new option for the control of metacestodes in the intermediate hosts is vaccination. There are several reports that cattle, sheep and goats can be successfully vaccinated against *T. ovis* and *T. saginata* (beef tapeworm) with recombinant antigens inducing high levels of protective immunity. This may give some hope for the commercial use of such vaccines against infection in

the near future. A vaccine to protect grazing animals against infection is an additional control method that focuses on grazing animals instead of the dog (Health et al., 2003). Recombinant oncosphere antigens have been used in the development of effective vaccines for the prevention of cysticercosis caused by *Taenia ovis*, *Taenia saginata*, *Taenia solium* and hydatid disease caused by *Echinococcus granulosus* (Lightowlers, 2006).

Vaccination with a recombinant oncospheral *E. granulosus* antigen (EG95) induces high degrees of protection, reducing the cyst numbers in vaccinated sheep by approximately 90-100% (Health et al., 2003). A high degree of immunity (about 80%), persists for six months (in absence of re-infection), and pregnant ewes vaccinated before lambing transfer high levels of antibody to their lambs (Health and Lightowlers, 1997). A vaccine to protect sheep, goats, and bovines against hydatid disease caused by the cysts of *Echinococcus granulosus*is prepared as a recombinant fusion protein expressed in *Escherichia coli* . Solubilised inclusion bodies are injected, together with Quil A, subcutaneously on two occasions 1 month or more apart, and induce protection against infection which lasts for at least 12 months. A third injection given 6-12 months after the second injection induces a high and long-lasting protection against artificial or natural challenge infections (Heath *et al.*, 2003).

The life cycles of *E. granulosus* and *E. multilocularis* include two hosts: an intermediate host and a definitive host. Effective hydatidosis/ecchinococcosis control programs show that prevention of transmission to either host can reduce or even eliminate the infection in human and livestock populations. Therefore, if either or both hosts can be vaccinated, the effect will be to improve and more rapidly expedite control. The sylvatic nature of the life cycle of *E. multilocularis* makes a vaccination approach to control unlikely (Heath and Lawerence, 1994).

Vaccination of the Intermediate Host:-vaccination of the intermediate host is a burgeoning area that has moved forward considerably in recent years following the development of a recombinant vaccine against *Taenia ovis* infection in sheep (Heath *et al.*, 1996). A similar approach has been applied successfully to develop a recombinant vaccine against *E. granulosus*. Earlier, a range of different antigens including cyst fluid (Dada and Belino, 1981; Heath *et al*, 1992), cyst membranes and protoscolices had been used as prototype vaccines against *E. granulosus*. However, oncospheres or oncospheral antigens induce much higher levels of protection in sheep and mice against challenge infection (Lightowlers and Gottstein, 1995; Lightowlers *et al.*, 1996;

Lightowlers *et al.*, 1999; Lightowlers *et al.*, 2000). A vaccine, based on a single polypeptide antigen derived from oncospheres and produced in *Escherichia coli* using recombinant DNA technology has been successfully developed for use against *T. ovis* in sheep. This technology has now been successfully applied to *E. granulosus* (Lightowlers et *al.*, 1996). Recently a hydatidosis vaccine (EG95) for sheep and goats based on non-living oncosphere antigens has been developed by Lightowlers and colleagues at the University Of Melbourne, Australia (Lightowlers and Gauci, 2001). Vaccine trials in Oceania, Argentina and China indicate that it induces >95% protection against experimental challenge infection in sheep and goats with similar protection seen in naturally challenged Chinese sheep (WHO and OIE, 2001). Immunity lasts at least one year after two immunizations, and immunity can be transferred passively to neonates with a colostral antibody from a vaccinated dam. It is thought that the combined use of public education, control measures in the definitive host (dogs) and vaccination of animal intermediate hosts (small ruminants) may provide an effective ongoing control of parasite transmission (Schantz, 2005).

2.7. Status of small ruminant metacestodes in Ethiopia

Reports regarding the prevalence of various metacestodes of small ruminants in Ethiopia were made from different parts of the country (Table 1). Hydatid cyst is the most abundant metacestodes followed by *C. tenucoillis.* The occurrence of *Coenurus cerebralis* had been documented in high land sheep only. There had been no documented report with regards to the presence or absence of *Cysticercus ovis* in small ruminants.

Cystic echinococcosis in farm animals causes considerable economic problems due to loss of the edible organs such as liver. Significant loss of meat and milk production and value of the fleece from infected sheep may also occur. These losses are of especial significance in countries of low economic output where small ruminants' production is of particular importance.

Prevalence of hydatid cyst and *Cysticercus tenuicollis* and economic losses due to organ condemnation has been reported by many externship students from various regions of Ethiopia. According to these reports the prevalence of hydatid cysts ranges between 10 and 30 % and 5 and 10 % in sheep and goats, respectively.

There are several reports on animal cysticercosis in different countries. The prevalence of metacestode of *T. hydatigena (C. tenuicollis)* was found to be 20% in Ethiopia (FAO, 1968). The prevalence of *E. grananulosus* in Ethiopia was recorded as 30% in cattle. 14% to 20% of bovine lungs were condemned for hydatidosis during meat inspection in different abattoirs of this country (FAO, 1968). Apart from reports in cattle, only very few records exist on hydatidosis and cysticercosis of sheep goat in Ethiopia.According to Tekelye, *et al.* (1988) out of 560 sheep slaughtered at Addis Ababa abattoir and examined for cysticercosis and hydatidosis, the prevalence of metacestodes of *T. hydatigena* (*C. tenuicollis*) was 37.1% and that of *E. granulosus* was 16.4%, 5% of the animals were infected with both metacestodes. *T. hydatigena* and hydatid cysts are common parasites of Ethiopian sheep and this is not surprising since animals are slaughtered in open fields and hence dogs and jackals have free access to the uncooked offal. Coenurosis is a problem of significance in the Ethiopian highlands, and out of the apparently healthy sheep examined 2.73 % were found harbouring *Coenurus cerebralis* (Achenef *et al.*, 1999).

Table 1: Reports on the prevalence of metacestodes of small ruminants from different abattoirs in Ethiopia

Place	Metacestode type	Animal Host	Prevalence (%)	Source
Gonder abattoir	Hydatid cyst	Sheep, goat	8.7 and 4.6	Tamane, 1986
Hararge region	Hydatid cyst	Sheep, goat	9.38 and 6.51	Wubet,, 1987
Jimma abattoir	Hydatid cyst	Sheep	10.1	Abduljewad, 1988
Addis Ababa abattoir	Hydatid cyst	Sheep, goat	40.6 and 70.05	Gemeda,, 1988
Melge Wondo	Hydatid cyst	Sheep, goat	6.0 and 1.5	Muktar, 1988
Woliata	*C. tenuicollis*	Sheep, goat	25.8 and 16.3	Muktar, 1988
Desse	Hydatid cyst	Sheep	4.4	Yilikal, 1989
Desse	*C. tenuicollis*	Sheep	46.1	Yilikal,, 1989
Arsi region	Hydatid cyst	Sheep	21.18	Alemayehu, 1990
Addis Ababa abattoir	*C. tenuicollis* Hydatid cyst	Sheep Sheep	37.1 16.4	Tekleye, 1988 Tekleye *et al.*, 1988
East Shewa	Hydatid cyst	Sheep, goat	6.6 and 2.7	Yemane, 1990
Sodo	Hydatid cyst	Sheep, goat	18.8 and 9.3	Fikre, 1994
Nekemt	Hydatid cyst	Sheep	22.2	Bersisa, 1994
Addis Ababa	Hydatid cyst	Sheep, goats	9.1, 5.9	Koskei, 1999
Derebirhan	*Coenurus cerebralis*	sheep	2.73	Achenef *et al.*, 1999
Sheno Sheno	*Coenurus cerebralis* *C. tenuicollis*	Sheep Sheep	37.3 40.3	Fekadu, 2003 Fekadu, 2003

3. MATERIALS AND METHODS

3.1. Description of study area and study population

3.1.1. Study area

The study was carried out in three export abattoirs namely ELFORA and Hashim export abattoirs located in Debre Zeit and Luna export abattoirs situated in Mojo. There are three abattoirs, two export abattoirs (ELFORA and Hashim) and one municipal abattoir

Mojo is a town located at 70km distance from Addis Ababa in southeastern direction. Two export abattoirs (Mojo modern and Luna abattoirs), 25 butcheries and one municipal abattoir are found in this town. The Luna and Mojo modern Export slaughterhouses started work in 2003 and Slaughter sheep, goats and cattle and export mutton, goat meat and veal to Saudi Arabia, United Arab Emirate and Yemen and occasionally beef to the Republic ofCongo.

3.1.2. Study population

The study population constituted of local breeds of sheep and goats coming from lowland and midland areas of the country and slaughtered at the three export abattoirs found in Debre Zeit and mojo towns. All slaughtered animals were males. According to the information obtained from the abattoirs, the average annual slaughter of each abattoior is about 30,000 sheep and 100,000 goats. It was not possible to exactly trace back the origin of animals slaughtered, because animals from different origin are mixed before or after they arrive at the abattoirs however; it is generally known that majority of the slaughter animals come from places such as: Borana, Guji, East and West Harage, Awash, Matahara, Afar, Wollo, Tigray and Shewarobit areas which represent the lowland and midland regions of the country.

3.2. Study design

Cross-sectional observational study type was used for prevalence determination of small ruminant metacestodiasis by post mortem examination of carcasses, viscera and heads of sheep and goats slaughtered at export abattoirs ELFORA and Hashim (Debre Zeit); and Luna (Mojo).

3.3. Determination of sample size

3.3.1. Sample size required for the study of *C. tenuicollis*, *C. ovis* and hydatid cyst

From each of the three export abattoirs and for each species of animals (sheep and goats) the sample size was determined using the win Episcope 2.0 epidemiological software (Thrusfield, 2001). Accordingly assuming the expected prevalence of the three metacestodes in small ruminants to be 20 % based on previous preliminary surveys, conducted in some abattoirs (Tekleye *et al.*, 1988; Jobre *et al.*, 1996) the sampe size required from each abattoir was 492 animals (246 sheep and 246 goats) at 95% confidence level and 5 % expected error. Thus, a total of 1476 animals were randomly sampled from both species and examined for the presence of metacestodes in the three export abattoirs, namely ELFORA, Hashim (Debre Zeit) and Luna (Mojo).

3.3.2. Sample size required in the study of coenurosis

To determine the sample size for the study on *Coenurus cerebralis*, the assumed prevalence was 5 % for both species based on previous works done inside and outside the coutry (Achenef et at., 1999; Abo-Shehada *et al.* 2002), the sample size required for each species at 95 % confidence level and 5 % accepted error was 75 sheep and 75 goats from each abattoir. Therefore a total of 450 animals (225 sheep and 225 goats) were randomly sampled from the three export abattoirs.

3.4. Study methodology

3.4.1. Active abattoir survey

A total of 1476 sheep and goats presented for slaughter at ELFORA, Hashim and Luna abattoirs were examined for the presence of metacestodes (*Cyticercus tenuicollis, Cysticercus ovis* and hydatid cyst) following the standard and routine meat inspection procedures. The inspection procedure used during the post mortem examination consisted primary examination, followed by a secondary examination if evidence of metacestodes was found. The primary examination involved visual inspection and palpation of organs and viscera.

The secondary examination involved further incisions into each organ if a single or more cysts found. The liver, lungs, heart, spleen, mesentery and omentum of each animal were examined grossly. Each organ was also incised once or twice with a knife. Whenever and wherever the cysts are present, they were removed, put in polythylne bags separately, lebelled and then taken to the laboratory for further studies. Identification of cysts was done in the parasitology laboratory of the Faculty of Veterinary Medicine based on the morphological criteria described by Soulsby (1982) for each of the metacstodes. During the survey, detailed records about the species, age of the animals; number, size, location and viability of the cysts (whether the cysts are live or dead) were kept. The origin (whenever possible) and age of each animal was recorded. The age of the animals was estimated on the basis of the dentation formula described by Gatenby (1991) and Mike (1996) annexes (2 and 3).

In an attempt to detect the presence of coenurosis, a total of 450 sheep and goats presented for slaughter in the above mentioned three abattoirs were randomly selected, marked with color paint while in the liarage and antemortem examination was conducted to observe any specific clinical signs (neurological signs). At post mortem the heads of these animals were removed and opened according to the technique described by King *et al* (2000). The head was removed by ventral disarticulation of the atlanto-occipital joint and, after removal of the skin; the area just caudal to the frontal bone was cut cross-sectionally with a saw, followed by two parallel cuts on the parietal bone. The bone is removed using a chisel and hammer and the meninges incised with a scalpel blade, to expose the brain. A detailed examination was made to detect gross pathological lesions. Cyst locations were recorded and their sizes measured. The cystic fuid was measured

using a measuring cylinder after rupturing the cyst on a petri dish. The recovered scolices were counted using stereomicroscope. Cyst identification was done on the basis of the morphologic characteristic of the cyst (Soulsby, 1982).

3.4.2. Laboratory Diagnosis

3.4.2.1. Viability test for hydatid cyst

Cysts or portions of infected tissue were examined for fertility and larval viability. The fluid contained within the hydatid cyst was aspirated and examined microscopically for protoscoleces and for their viability. Viability of protoscoleces was assessed by observation under high power (x100) of flame cell activity and the use of an eosin exclusion test (Mcpherson, 1983).

Microscopic examination of the cyst fluid was conducted to look for the characteristic protoscoleces, which can be either invaginated or evaginated. The content of the cyst is poured in to a petridish and examined under objective X40 magnification for the assessment of condition of the cyst. If the prtoscolices are present, they are seen as white dots on the germinal epithelium or brood capsule (Hydatid sands) within the suspension, the cysts are categorized as fertile. The collected cysts were also tested for viability by vital staining of sample with Eosin 0.1%. According to the procedure 0.1% eosin is added to the fluid to determine the viability of the protoscoleces. Viable protoscoleces exclude eosin whereas nonviable protoscoleces take up the dye (eosin). The technique differentiates between dead (red stained) and alive (unstained) protoscoleces. Sometimes the fertile and viable protoscoleces may be immobile and in such cases the movement can be stimulated by adding few drops of bile to the preparation (FAO, 1982).

3.4.2. 2. Viability test for C. ovis and C. tenuicollis

The cysts collected were transported to the parasitology laboratory at the Faculty of Vetetrinary Medicine for confirmation and viability study on the cysts. To determine the viability, the cysts were incubated at 37°C in 40% sheep bile solution diluted in normal saline for 2hrs (McCool, 1979). Cysts were considered viable if the head evaginated within two hours, then the identification of the cysts was done based the morphlogical parameters set for the metacestodes. *C. tenuicollis* was differentiated from *C. ovis* on the basis of its relatively larger size, less number

of hooks, the position of the head and neck in relation to caudal bladder and also the location of the cyst in the body of the host (Ransom, 1913; Arundel, 1972; OIE, 2004).

3.5. Data analysis

The data collected from the two study areas were recorded in the format developed for this purpose (Annex 1) later on entered into the Microsoft Excel 2000 pogram of the computer separately and analyzed using STATA 7.0. Confidence intervals for prevalences were calculated using the win episcope 2.0 epidemiological software (Thrusfield, 2001). The prevalence of each of the parasite (meacestode) identified were computed. The infection rate was calculated on the basis of species, abattoir and age groups and analyzed to see the association among different variables. The Pearson's chi-square (x^2), the Fisher exact tests were used to test the existence of differences in prevalence between species and age groups prevalence and feritility of the cysts and age of the animals. A statistically significant association between variables is considered to exist if the computed p-value is less than 0.05.

4. RESULTS

4.1. Overall prevalence of metacestodes

Out of 1476 carcasses, organs and viscera of sheep and goats examined at the three export abattoirs (ELFORA, Hashim and Luna) the overall prevalence of the three metacestodes (*C.tenuicollis and C.ovis,* hydatidcyst) were 32.7% , 1.4% 2.4%, in sheep and 34.7%, 0.3% 2.6%, in goats respectively. Out of 450 heads (skulls) of sheep and goats opened and examined at postmortem the overall prevalence of *C.cerebralis* at the three abattoirs was 2.2% and 12.4% in sheep and goats respectively (Table 2). The found prevalence of *C.ovis* was significantly different between sheep and goats ($P < 0.001$).

Table 2. The overall prevalence of metacestodes in examined sheep and goats.

Type of metacestode	No.examined		No.infected (% prevalence)		95 % CI for prevalence	
	Sheep	Goats	Sheep	Goats	Sheep	Goats
C. tenuicollis	738	738	241 (32.7)	256 (34.7)	29.4-36.2	31.4-38.3
Hydatid cyst	738	738	18 (2.4)	19 (2.6)	1.5-3.8	1.7-4.0
C. ovis	738	738	10 (1.4)	2 (0.3)	0.7-2.5	0.1-1.1
C. cerebralis	225	225	5 (2.2)	28 (12.4)	0.9-5.3	8.8-17.6

4.2. Prevalence of metacestodes on the basis of age

Analysis of age wise prevalence of *C. tenuicollis* indicated that the difference in prevalence among the three age groups in both sheep and goats were slightly significant ($P < 0.005$). The intensity of infection was higher in older animals than in the younger ones; contrary to this observation the extent or degree of damage incurred by the migrating *C.tenuicollis* larvae was sevre in younger animals than in the older ones.

The prevalence of *C. ovis* among the three age groups was analysed and showed significant difference ($P<0.05$). The result revealed that only the younger age group in both sheep and goats were found to harbour *C. ovis*.

As to the the prevalence of hydatid cyst with relation to the age of animals higher infection rates were observed in older animals and statistical analysis of the results showed that there was slight positive correlation between age of sheep and goats and infection rate with hydatid cysts ($r = 0.07$).

The prevalence of *Coenurus cerebralis* in relation to the age of the animals examined showed that there was significant difference in prevalence rate among the three age categories ($P < 0.001$). According to results the highest infection rate was observed in the youngest age group. The Prevalence of metacestodes on age basis is presented is presented in table 3.

Table 3. Prevalence of the four metacestodes according to the age category

Metacestode	Age category	No. examined		No. of positives (%)		95 % CI for prevalence	
		Sheep	Goats	Sheep	Goats	Sheep	Goats
C. tenuicollis	0.5-2	246	246	66 (26.8)	57 (23.2)	21.2 - 32.4	17.9 - 28.5
	>2-3	246	246	82 (33.3)	83 (33.7)	27.4 - 39.3	27.8 - 39. 7
	>3	246	246	93 (37.8)	116(47.1)	31.7 - 43.9	40.9 - 53.4
C. ovis	0.5-2	246	246	10 (1.4)	2(0.3)	0.7-2.5	0.1-1.1
	>2-3	246	246	0	0	_	_
	>3	246	246	0	0	_	_
Hydatid cyst	0.5-2	246	246	3 (1.2)	2(0.8)	0.4-3.8	0.2-3.2
	>2-3	246	246	5 (2.0)	6(2.4)	0.9-4.8	1.1-5.4
	>3	246	246	10 (4.1)	11(4.5).	2.2-7.5	2.5-8.0
C. cerebralis	0.5-2	75	75	4 (5.3)	19 (25.3)	3.2-8.8	18.5-34.8
	>2-3	75	75	1 (1.3)	8 (10.7)	0.7-2.7	7.1-16.1
	>3	75	75	0 (0)	1 (1.3)	--	0.7-2.7

4.3. Prevalence of metacestodes by abattoir

The data on prevalene of the metacestodes (*C. tenuicollis, C. ovis*, hydatid cyst and *Coenurus cerebralis*) in the three study abattoirs (ELFORA, Hashim and Luna) was analysed and the results showed that the differences in prevlence among the three abattoirs was not significant ($P > 0.05$). The prevalence of metacestodes on the abattoir basis is shown presented below (Table 4).

Table 4. The prevalence of metacestodes of small ruminants in the study abattoirs

Metacestode	Abattoir	No. examined		No. of positives (%)		95 % CI for prevalence	
		Sheep	Goats	Sheep	Goats	Sheep	Goats
C. tenuicollis	ELFORA	246	246	75 (30.5)	92(37.4)	25.2-36.8	31.8-44.0
	Hashim	246	246	88 (35.8)	94(38.2)	30.3-42.3	32.6-44.8
	Luna	246	246	78 (31.7)	70(28.5)	26.4-38.1	23.3-34.7
C. ovis	ELFORA	246	246	0(0)	0(0)	—	—
	Hashim	246	246	4 (1.6)	1(0.4)	0.6-4.3	0.1-2.9
	Luna	246	246	6 (2.4)	1(0.4)	1.1-5.4	0.1-2.9
Hydatid cyst	ELFORA	246	246	4 (1.6)	3(1.2)	0.6-4.3	0.4-3.8
	Hashim	246	246	6 (2.4)	9(3.6)	1.1-5.4	1.9-6.9
	Luna	246	246	8 (3.2)	7(2.8)	1.6-6.4	1.4-5.9
C. cerebralis	ELFORA	75	75	0	2(2.7)	_	0.7-10.5
	Hashim	75	75	2 (2.7)	5(6.7)	0.7-10.5	2.9-15.5
	Luna	75	75	3	21(28.0)	1.3-12.1	19.5-40.3

4.4. Organ distribution of cysts in infected sheep and goats

4.4.1. *C .tenuicollis*

When the data on distribution of cysts in the organs/ viscera of infected animals is analysed and summarized in majority of the animals harbouring *C. tenuicollis* the cysts had a tendancy to be located more in the omentum and mesentry and peritoneum than in the liver. Only few small

cysts were observed attached to the surface of the liver. Chi sqare anlysis the result showed that there is significant difference in cyst burden between the liver and omentum ($P < 0.001$). The highest cyst burden was encountered in ometum and mesentry and lower percentage were found in other organs (Table 5). The distribution of cysts in the organs of infected sheep and goats is summarized and presented in. Among 1476 livers examined in the three abattoirs during the study period significant proportions (18.8%) were condemned due to *C. tenuicollis* infection (Table 6).

Table 5. Ditribution of *Cysticercus tenuicollis* in the organs of infected animals.

	Organ predilction of cyst		
Postive animals	Liver	Omentun and mesentry	Peritoneum
Sheep	108	250	86
Goats	135	231	120
Total	243	481	206

Table 6.Total number of condemned livers and % of liver condemnation due to *C. tenuicollis* among the examined livers.

Abattoir	No.of livers examined	Total liver condemned	No. (%) of livers condemned due to *C. tenuicollis*
ELFORA	492	310	95 (30.6)
Hashim	492	285	102 (35.8)
Luna	492	243	81 (33.3)
Total	1476	838	278 (18.8)

4.4.2. Hydatid cyst

The distribution of cysts in the internal organs showed significant varation between the two organs, lungs and liver in both animal species ($P < 0.001$). The cysts in both sheep and goats were found mostly in the lungs, that is 16 of the 18 sheep positive for hydatidosis (88.9%) had

cysts in the lungs, 18 of the 19 (94.7%) goats had the cysts in the lung, where as only in 3 of the positive animals (two sheep and one goat) the cysts were located in livers. The distribution of cysts in the internal organs of goats showed similar pattern to the distribution of cysts in sheep. The distribution of recovered hydatid cysts in the two animal species is summarized and presented in (Table 7).

Table 7.The location of the hydatid cysts in the organs of infected sheep and goats.

Animals	Total examined	No.infected	No.of cyst (%)	
			Lungs	Liver
Sheep	738	18	16 (88.9)	2 (11.1)
Goats	738	19	18 (94.7)	1 (5.3)
Total	1476	37	34 (91.9)	3 (8.1)

4.4.2.1. Fertility and Viability of cysts

The total number of hydatid cysts recovered was 118 (4 from the liver only in sheep) and 114 from the lungs in both sheep and goats. The difference in the rates of cysts between lungs of sheep and goats was not statistically significant ($P > 0.05$).The differences in the rates of hydatid cysts between lung and liver were significant ($P < 0.05$ Out of the 118 recovered cysts 58 was fertile while 60 cysts were sterile (unfertile). Of the fertile cysts 25 and 31 cysts were recorded in the lungs of sheep and goats respectively. Of the 60 sterile cysts recovered from the lungs of both species 22 were in sheep and 38 were in goats. Out of 4 cysts recovered from the liver of sheep 2 cysts were fertile while the remaining ones were sterile. The overall fertility rate of the cysts is 49.2 % and the viability rate was 93.1%. The cysts were of various sizes and their number varied between 1-6 cysts in each animal. Table 8 shows the number, organ location of fertilile and sterile cysts, the percentage of viability in sheep and goats. The mean number of cysts in the lungs was 3.08 and showed increament with the age in the two animal species. Prevalence and intensity (i.e. the number of cysts/organ) were both found to increase with age.

Table 8. Number and location of fertilile and sterile hydatid cysts and the viability of recovered cysts.

Cyst location	No.of cysts examined		Fertile (%)		Sterile		No.of Viable cysts		Viability (%)	
	Sheep	Goats	Sheep	Goats	Sheep	Goats	Sheep	Goats	Sheep	Goats
Lungs	45	69	25(55.5)	31(44.5)	20	38	23	29	92	93.5
Liver	4	0	2(50)	0(0)	2	0	2	0	50	0
Total	49	69	27(55.1)	31(44.9)	22	38	25	29	92.6	93.5

4.4.3. *Cysticercus ovis*

As to the location of cysts in positive animals, *C. ovis* was found in the heart muscle in 7 of 10 sheep (70%), in the muscle of diaphragm in 3 of 10 sheep (30%). In the two infected goats cysts were recovered from cardiac muscle only. All of these cysts were viable.

4.4.4. *Coenurus cerebralis*

A total of 69 cysts were recovered from brains of the examined animals (61from goats and 8 from sheep). Out of the 33 infected animals from which cysts were recovered in both species only two of these goats and 3 of the sheep showed neurological symptoms. As to the location of cysts in the brains of infected sheep and goats, cysts were located in the left hemisphere, midian fissure and right hemisphere of the brain in 12, 14 and 7 animals respectively (Table 9). The number of sheep and goats carrying varying number of *Coenurus cerebralis* cysts in their brain is also shown on Table 10.

Table 9. Location and the number of *Coenurus cerebralis* cysts in the brain of postive sheep and goats.

Animal	Location of cyst in brain (number of animals)						Total
	LHFB*	LHHB*	MFFB*	MFHB*	RHFB*	RHHB*	
Sheep	0	1	2	1	1	0	5
Goats	3	8	8	3	4	2	28
Total	3	9	10	4	5	2	33

* LHFB=Left Hemphisphere Fore Brain; *LHHB= Left Hemphisphere Hind Brain;

* MFFB=Midian Fissure Fore Brain; *MFHB= Midian Fissure Hind Brain

* RHFB= Right Hemisphere Fore Brain; *RHHB= Right Hemisphere Hind Brain

Table 10. Cyst burden in the brain of sheep and goats harbouring *Coenurus cerebralis*.

No. of Cyst per brain	No. of animals		Total No.infected	Total cyst count
	Sheep	Goats		
1	2	7	9	9
2	3	10	13	26
3	0	10	10	30
4	0	1	4	4
Total	5	28	33	69

5. DISCUSSION

The present study revealed that metacestodiosis is spreading among small ruminants coming from lowland and midland areas of the country. The spreading of infection is an indication of environmental contamination with the eggs of the adult dog tapeworms.

Cysticercus tenuicollis the most important and widely prevalent of the four metacestodes recorded in small ruminants slaughtered in the study abattoirs. Up to 33.7% of the slaughtered sheep and goats were found to be infected with *C. tenuicollis.* The prevalence of *C. tenuicollis* by species was slightly higher in goats (34.7%) as compared to sheep (32.7%). However this difference was not found statistically significant. Similar results were reported in goats in Nigeria (Dada and Belino, 1978; wNwosu, *et al.*, 1996). The results of this study are higher than that reported by other workers (Muktar, 1988; Folaranmi *et al.*, 1984; Pathak and Gaur, 1982; Rao *et al.*, 2003; Radfar *et al.,* 2005). The relatively higher prevalence of *C. tenuicollis* recorded in the study could be due to the variations in temperature, environmental conditions, the degree of pasture contamination and the way of raising and grazing of these animals which may favour the transmission cycle between ruminants and dogs. The age of the animals could also be another factor in these variations. The prevalence of *C. tenuicollis* found in sheep in this study (32.7%) is lower than that reported by Tekleye *et al.*, 1988; Yilkal, 1989; Fekadu, 2003; Pathak and Gaur 1982). However the findings of this study in sheep are higher than other reports (Dada and Belino, 1978; Rao *et al.*, 2003; Radfar *et al.,* 2005).

The prevalence by age revealed that higher infection rates was recorded in animals with the age above 3 years (37.8 % in sheep and 47.2 % in goats) followed by those between two to three years of age (33.3 % in sheep and 33.7 % in goats), the lowest prevalence was recorded in younger animals 6 months to one year old. These differences in prevalence rates between the age groups are statistically significant ($P<0.05$).

The prevalence of Hydatid cyst found in this study was 2.44% and 2.57% in sheep and goats respectively. Similar reports in sheep were made in some abattoirs in the country (Jobre *et al.*, 1994; The prevalevce rate recorded in this study is lower than that reported by other investigators in other abattoirs of this country (Tamane, 1986; Wubet, 1987; Abduljewad, 1988 Tekleye *et al.*, 1988; Muktar, 1988; Yilkal, 1989; Alemayehu, 1990; Yemane, 1990; Bersisa, 1994; Jobre *et al.*, 1994; Koskei,, 1999; Yimer *et al.*, 2005) and those reported from abroad (Al-Khalidi, 1998, Njoroge *et al.*, 2002; Umur, 2003; Dalimi, *et al.*, 2002, Ernest *et al.*, 2004). The lower prevalence found in both sheep and goats in the study may be ascribed to the origin of the slaughtered animals which, in majority of cases, is from the lowland areas where the environmental conditions such as high temperature and low humidity (adverse condition for survival of the egss of *Echinococcus granulosus*) exsist. The other resean could also be due to the fact that most of the animals presented for slaughter in these export abattoirs are young (below 3 years of age) because importer countries prefer meat of younger animals. It is established fact that prevalence of hydatid cyst increases as the age of animal increases (WHO/OIE, 2001). Therefore highest prevlenc rate is expected in older animals. The prevalence reported in goats in this study is higher than that repoted in goats by Muktar, 1988; Jobre *et al.*, 1996. The observed differences may be due to the origin of the examined animals and the presence of close associations between the intermediate hosts (in this case sheep and goats) and the final hosts, dogs.

The general trend of age-prevalence data was that the infection rate increased with age, for the two animal species. The data on infection rates among the three age categories of the sheep and goats were analysed. It was found that there was positive correlation between age of sheep and goats and infection rate ($r = 0.07$).

As to the predilection sites of cysts in the internal organs in sheep and goats, almost all of the cysts 92 % were located in lungs while only few 8% of cysts were found in the liver. The distribution of cysts in the internal organs of goats showed similar pattern to the distribution of cysts in sheep. Hence liver cysts were less frequent in both sheep and goats. The results showed that the occurrence of cysts was significantly ($P < 0.0001$) different between the two organs with a higher percentage of cysts being located in the lungs (Table 5). Similar results had been obtained in Ethopia by other workers (Tekleye *et al.*, 1988; Mersie, 1993; Jobre *et al.*, 1996). Other similar reports from abroad also indicated that lungs were found to be the most infected

organ in cattle, Buffallo and sheep (Pandey *et al.*, 1988; Maharjan, 1999; Manandhar, 2005; Kumari, *et al.*, 2000). The findings in the study were thus in conformity with previous studies made in Ethiopia and abroad. The organ predilection may be due to the strains of *E. granulosus* involved as certain strains have been shown to have high predilection to specific organs Also, this organ predilection could be due to the age of the animals at the time of infection (Thompson and Lymbery, 1988; Eckert and Thompson, 1997).

Out of the total of 118 hydatid cysts recovered from 37 animals (18 sheep and 19 goats) 49.15% and 50.85% harbored fertile and sterile cysts respectively. So the percentage of fertile cysts was found to be slightly lower than sterile cysts. But these two proportions were not significantly different ($P>0.05$). Examinations of the fertility status of the cysts in previous studies on sheep and goats in the country reported fertility rate of 80-85% in sheep and 56-59% in goats at Debre Zeit and South Omo areas (Jobre *et al.*, 1996). The relatively lower fertility of cysts found in this study may be attributed to the younger age of examined animals, as increased number of fertile cysts tends to occur in older animals. It has been documented that it may take 2-4 years for the occurrence of fertile cysts in sheep (WHO/ OIE, 2001). This may also be applied to the occurrence of fertile cysts in goats. This argument is further supported by Umur (2003) that fertile cysts are most likely found in older animals while sterile ones are found in young animals. The fertility of cysts is an important factor that can influence the transmission of *E. granulosus*. Depending on the geographical situation, the nature of infected hosts and the sites of infection, cysts may have different fertility rates.

The prevalence of *C. ovis* recoreded in the study (1.4% and 0.3% in sheep and goats respectively) is the first documented report. Therefore, we couldn't discuss the results of the finding in comparision to other works in the country due to lack of documented information on the subject. When the results found were analysed on the basis of the age groups of animals, all of the viable cysts were recovered from animals belonging to the youngest age category of the examined animals (0.5 to < 2years). This may be due to the development of acquired resistance in older animals. *C. ovis* is a small cyst which may develop in any part of the musculature in sheep (Gemmell, 1970). When located located in the muscles of heart and diaphragm, cysts are readily detected during meat inspection but, when located in the large muscle masses of the carcass, they are almost impossible to detect unless the muscle is thinly sliced (Broadbent, 1972). Gemmell

(1970), in dicussing the location of C. ovis in experimentally infected sheep stated that only 30% of cysts are found in the heart, diaphragm and head.

Similar prevalence records of *C. ovis* in other countries of the world were made by some investigators (Belino and Dada, 1978 in Nigeria; El-Metenawy, 1999 at Bureidah abattoir, Saudi Arabia). Among the examined carcasses and organs of sheep and goats the simultaneous occurrence of *C. ovis* with other metacestodes (*C. tenuicollis* and hydatid cyst) in the carcass and/ or organs of the same animal were not encounterd. This may be explained in terms of cross protection that exsists between taenia species. Gemmell and Soulsby (1968) stated that there is cross protection between *T. hydatigena* and *T. ovis* in both pre and post encystment phases. Gemmell (1968) in New Zealand found that lambs previously exposed to *T. hydatigena* in the field were only slightly susceptible to infection with *C. ovis*.

Sheep measles or *C. ovis* have no public health significance and it is important solely as a cause of economic loss in the meat industry due to the fact that carcasses of sheep and goats harbouring *C. ovis* cysts are rejected for aesthetic reasons moreover meat of sheep and goats infected with these cysts is not accepted at export market. In the near future the prevalence may increase and as a consequence might become a threat to the present encouraging export market being practiced by the newly emerged export abattoirs in the country. The threat of *C. ovis* to the small ruminant's meat industry in Ethiopia is evident due to the present situation of improper disposal of offals being practiced. Some stray dogs have free access to condemned offals/organs and this may lead to the perpetuation life cycle between the intermediate hosts (sheep and goats) and the final hosts. In addition to the stray and other dogs the have also access to the offals/organs as these offals are sold as dog and cat feed at the road sides in Debre Zeit town maintainaning the life cycle between the small ruminants and dogs and may end in establishment of *C. ovis*.

Coenurosis is endemic in Ethiopia, especially in the highlands where 75% of the sheep population is found (Bergeon, 1968; Njau *et al*., 1990; Bekele *et al*., 1992; Acnenef, *et al*, 1999). To date very few investigations have been made on coenurosis and those previous works were only on in high land areas of the country and focused on high land sheep. The present study contributes additional information on the continued presence of coenurosis in Ethiopia and confirmed the occurrence of coenurosis in goats comiming from the lowland and midland areas

of the country. According to the findings of this study of the two animal species the highest prevalence (12.44%) was recorded in goats whereas the lowest (2.3%) was observed in sheep. The difference in prevalence between the two animal species was highly signifcant ($P < 0.001$). The observed difference might be due to the fact that the origin of the sampled animals could be from different localities with in the same agroecological zones. This finding in small ruminants coming from the lowland and midland regions of the country indicates that Coenurosis is problem significance in sheep and goats in these areas. Previous studies (Njau *et al*, 1988; Achenef *et al*, 1999; Fekadu, 2003) indicated that coenurosis is a problem of Ethiopian high land sheep. The findings of the present study in sheep is is in agreement with that reported by Achenef *et al.*, (1999) in apparently healthy animals. Positive non-clinical cases were also reported by Parihar (1988) in India.

The presence of coenurus in the brain has been reported to cause softening and pressure atrophy of the overlying skull, to the extent of perforation (Soulsby, 1982; Skerritt and Stallbaumer, 1984; Nooruddin *et al.*, 1996). This was not observed in this study, neither during clinical nor during post-mortem examinations.

As to the location cysts recovered from infected animals in 12, 7 and 14 animals cysts were located in the left, right cerebral hemispheres and in midian fissure of the brain respectively. The cyst may be localized in any part of the brain, more commonly in the cerebral hemisphere (Skerrit and Stallbaumer, 1984; Parihar, 1988). The size of the cyst(s) in apparently healthy animals was probably too small to create pressure and hence to induce clinical signs.

The presence of stray dogs on grazing areas greatly contributes to the existence of the disease. Dogs are routinely fed on offal, including sheep and goats' heads, which results in the maintaince of *Taenia multiceps* life cycle.

The fact that high percentage in young goats and sheep were infected might indicate that the contribution of coenurosis as a cause of culling young sheep and goats is very high in lowland and midland regions. One-year-old sheep and goats had the highest prevalence in the abattoir survey. The reasons for the lower prevalence of infection in older sheep and goats may be early culling of the infected young animals through selling or slaughtering before they reach old age or

die as a consequence of the disease. The reason for this may also be explained by the presence of acquired immunity in older or aged animals. Gemmell *et al.* (1987) suggested that most taeniid eggs are not capable of developing to mature metacestodes in older animals. It is also indicated that in the case of *T. hydatigena*, only 7% of eggs will transform into cysts. However, an important proportion of the remaining 93% still can stimulate immunity. This is further influenced by the fact that it requires alleast 10 eggs to stimulate immunity to *T. hydatidgena* in conditions of high infection pressure; immunity is life-long (Roberts et al., 1987).

6. CONCLUSION AND RECOMMENDATIONS

Among the four metacestodes whose prevalences was determined, *Cysticercus tenuicollis* was the predominant metacestode causing organ (liver) condemnation with consequent economic losses in the study export abattoirs practicing the slaughter of small ruminants and export meat of these animals. High prevalence of *Cysticercus tenuicollis* and severe liver damage in slaughtered sheep and goats were recorded in younger animals. The survey has established the presence of *Cysticercus ovis* in small ruminants and as to my knowledge this is the first documented report in the country. The prevalence of hydatid cyst recorded in both species of small ruminants in this study is low. The prevalence of *Coenurus cerebralis* recorded in goats was high and it is also the first documented report. Among the examined small ruminants the highest prevalence of coenurosis was recorded in younger goats.

Inappropriate disposal of abattoir materials being practiced by some of the abattoirs can enhance the continuation the life cycle between the intermediate and final hosts (dogs) and further may increase the risk of zoonotic infections (hydatidosis and coenurosis) to human beings residing in and around these towns where improper disposal of abattoir materials is being practiced. Based on the results of the present survey, the following recommendations are forwarded.

Metacestodiosis has been the cause of considerable economic loss and damage to basic human health. Therefore, it can be suggested that a control program in which pertinent agencies, such as public health, agricultural, and educational institutions participate directly by providing appropriate administrative, legal, technical, and economic support is necessary.

Immediate attention should be paid to the safe and controlled elimination of all condemned abattoir materials and the sale of contaminated offals and heads of sheep and goats as dogs' feed should be stopped.

Awareness creation programs should be launched for the butchers, abattoir workers, meat-sellers, and dog owners as to the danger of the metacestodes to human as well as animal health.

7. REFERENCES

Abduljawad, A. (1988): Hydatidosis: prevalence at Jimma abattoir. DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia.

Al-Khalidi, N. W. (1998): Cystic Echinococcosis (Hydatidosis) in Sheep, Goats, Cattle and Camels in Shahat Abattoir, Al-Jabal, Libya. Proceedings of the Third Annual Meeting for Animal Production under Arid Conditions, **1**:143-149.

Abidi, S. M.; Nazami, W. A.; Khan, P; Ahmad, M.; Irshadullah, M. (1989): Biochemical characterization of *Taenia hydatigena* cysticerci from goats and pigs. *Journal of Helminthology*, **63**:333-337.

Abo-Shehada, M.N.; Jebreen, E.; Arab, B.; Mukbel, R.; Torgerson, P. (2002): Prevalence of *Taenia multiceps* in sheep in northern Jordan. *Preventive Veterinary Medicine*, **55**:201–207.

Achenef, M.; Markos, T.; Feseha, G.; Hibret, A.; Tembely, S. (1999): *Coenurus cerebralis* Infection in Ethiopian Highland Sheep: Incidence and Observations on Pathogenesis and Clinical Signs. *Tropical Animal Health and Production*, **31**:15-24.

Alemayehu, L. (1990): Prevalence of Hydatidosis in cattle, sheep and goats, and Echinococcus granulosus in dogs in Arsi Adminstrative Region. DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia.

Anon, M. (1981): FAO/UNEP/WHO guidelines for surveillance, prevention and control of echinococcosis/hydatidosis. Geneva, Switzerland, World Health Organization.

Arcari, M.; Baxendine, A; Bennett, C. E. (2005): A-Z guide to Parasitology, Volume 8, larval Cestodes and Nematodes which Infect Man. Saved from http://www.soton.ac.uk.

Arundel, J.H. (1972): Review of Cysticercosis of sheep and cattle in Australia. *Australian Veterinary Journal*, **48**:140.

Bayer-Leverkusen, AG. (2000): General biology of tapeworms (Cestodes). Bayer AG, Animal Health Business Group, D-51368 Leverkusen.

Bersisa, K. (1994): Hydatidosis in Nekmete: Prevalence in slaughtered cattle and sheep, DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia.

Rao, T.B.; Prasad, P.V.V.; Hafeez M.D. (2003): Prevalence of *Cysticercus tenuicollis* infection in slaughtered sheep and goats at Kakinada, Andhra Pradesh. *Journal of Parasitic Diseases*, **27**:126-127.

Bowman, D.D. (1999): Georgis' Parasitology for Vetrinarians. 7th edn. USA, W.B. Saunders Company, pp.144–220.

Broadbent, D.W. (1972): Ovine Cysticercosis and canine Taeniasis in Victoria. *Australian Veterinary Journal,* **48:** 452-455.

Budke, C.M.; Deplazes, P; Torgerson, P.R. (2006): Global Socioeconomic Impact of Cystic Echinococcosis. *Emerging Infectious Diseases*, **12**:296-302.

CDC. (2005): Life cycle of *Echinococcus granulosus*. Centers for Disease Control and Prevention (CDC) [online]. Available at: http://www.cdc.gov/ncidod/dpd/parasites/.

Craig, P.S.; Rogan M.T; Allan J.C. (1996): Detection, screening and community epidemiology of taeniid cestode zoonoses: cystic echinococcosis, alveolar echinococcosis and neurocysticercosis. *Advances in Parasitology,* **38**:169–250.

Dada, B. J. and E. D. Belino (1978): Prevalence of hydatidosis and cysticercosis in slaughtered livestock in Nigeria. *The Veterinary Record*, **103**:311-312.

Dada, B. J. and Belino, E. D (1981): Immunization of sheep against cystic hydatidosis with homologous and heterologous metacestode antigens. *International Journal of Zoonosis,* **8**:20-25.

Dalimi, A.; Motamedib, G.H.; Hosseini, M.; Mohammadian, B.; Malaki, H.; Ghamari, Z.; Ghaffari F. and Far, F. (2002): Echinococcosis/hydatidosis in western Iran. *Veterinary Parasitology*, **105**:161–171

Deodhar, N.S. and Narsapur, V.S. (1968): "Pneumonitis Cysticecosa": a new disease condition of goats caused by migrating *Cysticercus tenuicollis* in the lungs. *Indian veterinary* Journal, **45**:202-204.

Eckert, J.; Deplazes, P.; Craig, P. S.; Gemmell, M.; Gottstein, B.; Heath, D. D.; Jenkins, J.; Kamiya, M. and Lightowlers, M. (2001): Echinococcosis in animals: clinical aspects, diagnosis and treatment. In: Eckert, J.; Gemmell, M.A.; Meslin, F.X. and Pawlowski, Z.S. (eds.), WHO/OIE manual on echinococcosis in humans and animals: a public health problem of global concern. World Organisation for Animal Health, Paris, France, pp.72-99.

Eckert, J. and Deplazes, P. (2004): Biological, epidemiological, and clinical aspects of echinococcosis, a zoonosis of increasing concern. *Clinical Microbiological Review*, **17**:107–25.

Erica, L.D.; Pedro L. M., and Robert, H. G. (1999): Oxfendazole Treatment of Sheep with Naturally Acquired Hydatid Disease. *Antimicrobial Agents and Chemotherapy*, **43**:2263–2267.

Ernest, E.; Kassuku, A. and Kazwala, R. (2004): Studies on the epidemiology of echinococcosis/hydatidosis in Ngorongoro district, Arusha region, Tanzania. *Int Arch Hydatid*, **35**:43-50.

FAO, (1968): Report to the Government of Ethiopia on Veterinary Parasitology Survey. FAO, Rome, pp.38.

FAO, (1982): Echinococcus/hydatidosis: surveillance, prevention and control. FAO/UNEP/WHO guidelines. FAO Animal Production and Health, Paper No. 29. Rome.

FAO, (2003): Diagnostic Manual on Meat Inspection for Developing Countries, http://www.fao.org.

Fekadu, D. (2003): A study on Cestodes and metacestodes of sheep in Sheno Agricultural Research Center, North Shewa, Ethiopia. DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia.

Fikre, L. (1994): Echinococcosis/hydatidosis in Konso (Southern Ethiopia). DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia.

Flisser, A.; Williams, K.; Laclette, J.P.; Larralde, C.; Ridaura, C. and Beltran, F. (1982): Cysticercosis: present state of knowledge and perspectives. Academic Press, NewYork, pp.55.

Folaranmi, D. O.; Usman, S.; Gimba, D. and Okwori, J. (1984): Taeniid infection of dogs in Zaria Nigeria. *International Journal of Zoonoses*. **11**:145-14.

Gemada, B. (1988): Preliminary study on hydatidosis Echinococcosis in livestock (cattle, sheep, goats and pigs) slaughtered at Addis Ababa. Abattoir. DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia.

Gemmell, M.A. and Roberts, M.G. (1998): Cystic echinococcosis (*Echinococcus granulosus*), In: Palmer, S.R.; Soulsby, E.J.L. and Simpson; D.I.H. (eds), Zoonoses. Oxford University Press, Oxford, United Kingdom, pp.665-688.

Gemmell, M.A.; Roberts, M.G.; Beard, T.C. and. Lawson, J.R. (2001): Quantitative epidemiology and transmission dynamics with special reference to *Echinococcus granulosus*. In: Eckert, J.; Gemmell, M.A.; Meslin, F.X. and Pawlowski, Z.S. (eds), WHO/OIE manual on echinococcosis in humans and animals: a public health problem of global concern. World Organisation for Animal Health, Paris, France, pp.143-156.

Gatenby, R.M. (1991): Sheep: In the Tropical Agriculturalist, Macmillan, TCTA, pp.6–10.

Gonzales, A.E.; Garcia, H.H.; Gilman, R.H.; Gavidia, C.M.; Tsang, V.C.; Bernal, T.; Falcon, N.; Romero, M. and Lopez-Urbina, M.T. (1996): Effective, single-dose treatment for porcine cysticercosis with oxfendazole. *American Journal of Tropical Medicine and Hygeine*, **54**:391–394.

Gonzalo-Orden, J.M.; Diez, A.; Altonaga, J.R.; Gonzalo, J.M. and Ordend, M. A. (1999): Computed tomographic findings in ovine coenurosis. *Veterinary Radiology & Ultrasound*, **40:**441-444.

Heath, D.D.; Lawrence, S.B. and Yong, W.K. (1992): *Echinococcus granulosus* in sheep: transfer from ewe to lamb of "Arc 5' antibodies and oncosphere-killing activity, but not protection. *International Journal of Parasitol*ogy, **22**:1017-1021.

Heath, D. D.; Holcman, B. and Shaw, R. J. (1994): *Echinococcus granulosus*: the mechanism of oncosphere lysis by sheep complement and antibody *International Journal of Parasitol*ogy, **24**:929-935.

Heath, D.D. and Lawrence, S.B. (1996): Antigenic polypeptides of *Echinococcus granulosus* oncospheres and definition of protective molecules. *Parasite Immunol*ogy, **18**:347-357.

Heath, D.D.; Jensen, O.; Lightowlers, M.W. (2003): Progress in control of hydatidosis using vaccination-a reviewof formulation and delivery of the vaccine and recommendations for practical use in control programmes. *Acta Tropica,* **85**:133-143.

Ibrahim, H. (1998): Small Ruminant Production Techniques. ILRI Manual 3. International Livestock Research Institute (ILRI), Nairobi, Kenya, pp.207.

Jackson, P.J. and Arundel, J.H. (1971): Identification of *Taenia* species. *Australian Veterinary Journal*, **47**:46.

Jenkins, D.J. (2002): Echinococcus in Australia: the role of wildlife in transmission, with particular reference to South Eastern Australia. In: Craig, P. and Pawlowski, Z. (eds), Cestode zoonoses: echinococcosis and cysticercosis, an emergent and global problem. IOS Press, Amsterdam, the Netherlands, pp.327-332.

Jobre, Y.; Lobago, F.; Tiruneh, R.; Abebe, G. and Dorchies, Ph. (1996): Hydatidosis in Three Selected Regions in Ethiopia: an Assessment Trial on its Prevalence, Economic and Public Health Importance. *Rev. Med. Vet.* **147**:797-804.

Jorgen, H. and Brian, P. (1994): The epidemiology, Diagnosis and Control of Helminth Parasites of Runinants.ILRAD, Nairobi, Kenya, pp.150.

Karim, M.A. (1979): A survey of coenurosis in sheep in Northern Iraq. *Tropical Animal Health and Production,* **11**:157–158.

King, Dodd, Newson and Roth (2002): The Necropsy Book. CIRAD, France, pp.25

Kittelberger, R.; Reichel, M.P.; Jenner, J.; Heath, D.; Lightowlers, M.W.; Moro, P.; Ibrahem, M. M.; Craig, P.S. and O'Keefe, J.S. (2002): Evaluation of three enzyme-linked immunosorbent assays (ELISAs) for the detection of serum antibodies in sheep infected with *Echinococcus granulosus*. *Veterinary Parasitology,* **110**:57-76.

Kumari, N.; Prasad, L.N.; Sinha, B.K. (2000): A note on Pulmonary hydatidosis in goats. *Indian Journal of Veterinary Pathology*, **24**:130-135.

Lightowlers, M.W. and Gottstein, B. (1995): Echinococcosis/hydatidosis: antigens, immunological and molecular diagnosis. In: Thompson, R. C. A. and Lymbery, A. J. (eds.), The biology of Echinococcus and hydatid disease. CAB International, Wallingford, United Kingdom, pp. 355-410.

Lightowlers, M.W.; Lawrence, S.B.; Gauci, C. G.; Young, J. Ralston, M. J.; Maas, D. and Heath, D.D. (1996): Vaccination against hydatidosis using a defined recombinant antigen. *Parasite Immunology*, **18**:457-462.

Lightowlers, M. W.; Jensen, O.; Fernandez, E. J.; Iriarte, A.; Woollard, D. J.; Gauci, C.G.; Jenkins, D. J. and Heath, D. D. (1999): Vaccination trials in Australia and Argentina using the EG95 recombinant vaccine in sheep. *International Journal of Parasitology*, **29**:531-534

Lightowlers, M. W., Flisser A., Gauci C. G., Heath, D. D., Jensen O., and Rolfe, R. (2000): Vaccination against cysticercosis and hydatid disease. *Parasitology Today,* **16**:19

Lightowlers, M.W. and Gauci, C.G. (2001): Vaccines against cysticercosis and hydatidosis. *Veterinary Parasitoogy,* **101**: 337–352.

Lightowlers, M. W. (2006): Vaccines against cysticercosis and hydatidosis: Foundations in taeniid cestode immunology, *Parasitology International,* **55***:* 39 – 43.

Manandhahar, S. (2005): Occurrence of Echinococcosis/Hydatidosis in Slaughter Buffaloes and Echinococcus granulosus in Stray Dogs in Kathmandu Valley, Nepal, Msc thesis Changmai University and Freie Universitat Berlin, pp. 98.

McManus, D.P., Zhang, W. J., Bartley, P.B. (2003): Echinococosis. *Lance,* **362**: 1295-1304.

Magambo, J., Njoroge, E., Zeyhle, E. (2005): Epidemiology and control of echinococcosis in sub-Saharan Africa, *Parasitology International*, **20**:30-33.

Maharjan, M. (1999): Prevalence of Hydatidosis in Water Buffaloes of Western part of Kathmandu. In: Third National Conference on Science and Technology. Nepal Royal Academy of Science and Technology, pp. 587-599.

McPherson, C.H.L. (1983): An active intermediate host role for man in the life cycle of Echinococcus qranulosus in Turkana, Kenya. *American Journal of Medical Hygeine,* **32**: 397-404.

Mcpherson, C. N. L. (2001): Epidemiology of *Echinococcus granulosus* in transhumant situations, In: Eckert, J.; Gemmell, M. A.; Meslin, F.X. and Pawlowski, Z. S. (eds.), WHO/OIE manual on echinococcosis in humans and animals: a public health problem of global concern. World Organisation for Animal Health, Paris, France. pp. 156-163.

Mccool C. J. (1979): Distribution of cysticercus bovis in lightly infected young cattle. *Australian veterinary Journal*, **55** (5), 214-126.

Mersie, A. (1993): Survey of Echinococcosis in Eastern Ethiopia. *Veterinary Parasitology,* **47**: 161-163.

Mike S. (1996): Goats: In the Tropical Agriculturalist; Macmillan, TCTA, pp.79 – 83.

Morris, R.S. (1988): The effects of disease on productivity and profitability of livestock: How should it be assessed? IN: proceedings of New Zealand society of Animal production, **48**:117-123.

Muktar, R. (1988)): Preliminary Survey of gastro-intestinal helmiths in dogs, *Cysticercus tenuicollis* in sheep and goats, hydatidosis in sheep, goats and cattle, at Wolaita Awraja.

DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia.

Njau, B.C., Kasali, O.B., Scholtens, R.G. and Mesfen, D. (1988): Review of sheep mortality in Ethiopian highlands, (ILCA Bulletin No. 31, Addis Ababa, Ethiopia), 19-22.

Nooruddin, M., Dey, A.S., Ali, M.A. (1996): Coenurosis in Bengal goats of Bangladesh. *Small Ruminant Research*, **19**:77–81.

Nwosu, C.O., Ogunrinade, A.F., Fagbemi, B.O. (1996): Prevalence and seasonal changes in the gastro-intestinal helminthes of Nigerian goats. *J. Helminthol.* **70**:329-333.

Njoroge, E.M., Mbithi, P.M., Gathuma, J.M., Wachira, T.M., Gathura, P.B, Magambo, J.K. (2002): A study of cystic echinococcosis in slaughter animals in three selected areas of northern Turkana, Kenya. *Vet Parasitol*. **104**:85–91.

OIE. (2004): Hydatidosis: in Manual of Diagnostic Tests and Vaccines for Terrestrial Animals, 5th ed.*http:/*WWW.OIE.Int.

Oryan, A. M. Oghaddar, N. and Gaur, S.N.S. (1993): Metacestodes of sheep with special reference to their epidemiological status, pathogenesis and economic implications in Fars Province, Iran. *Veterinary Parasitology,* **51**:231-240.

Pathak, K.M.N., Gaur, S. N.S. and Sharma, S.N. (1982): The Pathology of *Cysticernes tenuicollis* infection in goats, *Veterinary Parasitology,* **11**: 131-139.

Pathak, K. M. L.; Gaur, S. N. S. (1982): The incidence of adult and larval stage *Taenia hydatigena* in Uttar pradesh (India). *Veterinary Parasitology,* **10**:91–95:

Pandey, V.S., Ouhelli, H., Moumen, A. (1988): Epidemiology of Hydatidosis and Echinococcosis in Ouarzazate, the pre-Saharan region of Morocco. *Ann. Trop. Med. Parasitol.* **82**:461-470.

Koskei, P.K. (1999): Prevalence and strain differentiation of *Echinococcus granulosus* in some selected sites of Ethiopia. Msc Thesis, Addis Ababa University and Freie Universitat Berlin.

Radfar, M. H., Tajalli, S. Jalalzadeh, M. (2005): Prevalence and morphological characterization of *Cysticercus tenuicollis* (*Taenia hydatigena* cysticerci) from sheep and goats in Iran. *Vet. Arhiv.* **75**:469-476

Radostits, O.M., Blood, D.C., Gay, C.C. (1994): Veterinary medicine. A textbook of diseases of cattle, sheep, pigs, goats, and horses. 8th edn. London: Baillere, Tindall, pp. 1223 – 1268.

Ransom, B.H. (1913). *Cysticercus ovis*, the cause of tapeworm cysts in mutton. *Journal of Agricultural Research,* **1**:15-60.

Rausch, R.L. (1995): Life cycle patterns and geographical distribution of *Echinococcus* species. In: Thompson, R.C.A. and Lymbery, A.J. (eds.). Echinococcus and Hydatid Disease, CAB International, Wallingford, UK, pp. 89–134.

Reincecke, R.K. (1983): Veterinary Helminthology. Butterworths Durban. Professional publishers PTY. Ltd. 279- 296.

Rickard, M. D., and Williams J. F. (1982): Hydatidosis/cysticercosis: immune mechanisms and immunization against infection. *Advances in Parasitology,* **21**:229-296.

Roberts, M.G., Lawson, J.R. and Gemmell, M.A. (1987): Population dynamics in echinococcosis and cysticercosis: Mathematical model of the life cycles of *Taenia hydatigena* and *Taenia ovis*. *Parasitology,* **94**:181–197.

Sanyal, P. K. and Sinha, P. K. (1983): Caprine Metacestodiasis: Incidence in West Bengal. *Haryana Veterinarian,* **22**:38–40.

Schantz, P. M. (2005): Progress in diagnosis, treatment and elimination of echinococcosis and cysticercosis. *Parasitology International*, **20**:30-37.

Sharma, D.K., and Chauhan, P.P.S. (2005): Coenurosis status in Afro-Asian region: A review *Small Ruminant Research*, **30**:1-6.

Skerritt, G.C. and Stallbaumer, M.F (1984): Diagnosis and Treatment of *Coenurosis* (gid) in sheep. *Veterinary Record,* **5**:399.

Skerritt, G. C. (1991): Coenurosis. In: Martin, W. B. and Aitken, I. D.(ed.). Diseases of Sheep ,2nd edition. Blackwell Scientific Publications, Oxford, pp. 65-70.

Soulsby, E.J.L. (1982): Helminths, Arthropods and Protozoa of Domesticated Animals, Seventh Edition. Balliere Tindall, London, UK, pp.809.

STATA-Intercooled stata 7.0. (Stata corp. 1984 - 2001, collage station, Texas, 77845, USA).

Tamane, M. (1986): Preliminary Study of Ehcinococcosis in livestock in Gondar. DVM Thesis Addis Ababa. University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia.

Tekleye, B.; Mukasa-Mugerwa, E.; Kasali, O. B. (1988): The prevalence of cysticercosis and hydatidosis in Ethiopian sheep. *Veterinary Parasitology*, **28**:267–270.

Thompson, R.C.A, and Allsop C.E (1988): Hydatidosis: Veterinary perspectives and annotated Bibliography: C.A.B International, pp.285

Thompson, R.C.A., Lymbery, A.J. (1988): The Nature, Extent and Significance of Variation within the Genus *Echinococcus. Advances in Parasitology,* **27**:210-258.

Thompson, R.C.A. (1995): Biology and systematics of Echinococcus. In: Thompson R.C.A. and Lymbery A.J. (eds). Echinococcus and Hydatid Disease. CAB International, Wallingford, UK, pp.1–50.

Thompson, C. R. A., and McManus, D. P.. (2001): Aetiology: parasites and life cycles, p. 1-19. In J. Eckert, M. A. Gemmell, F.X. Meslin, and Z. S. Pawlowski (ed.), WHOI/OIE manual on echinococcosis in humans and animals: a public health problem of global concern. World Organisation for Animal Health, Paris, France.

Torgerson, P.R., Williams, D.H., Abo-Shehada, M. N. (1998): Modelling the prevalence of Echinococcus and *Taenia species* in small ruminants of different ages in northern Jordan. *Veterinary Parasitology,* **79**:35-51.

Troncy, P.M. (1989): Helminths of Livestock in Tropical Africa, In: Manual of Tropical Veterinary Parasitology. The technical center for Agricultural and rural Cooperation CTA International, Wallingford, UK, pp. 1-169.

Thrusfield, M., Ortega, C., Blas, I. DE., Noordhuizen, J.P., Frankena, K. (2001): Win Episcope 2.0. Improved epidemiological software for Veterinary Medicine. *Veterinary record*, **148:**567-572.

Tigari, M., Howard, B.R. and Boargob, A. (1987): Clinical and Radiographical diagnosis of *Coenurus cerebralis* in sheep and its surgical Treatment. *Veterinary Record*, **20**:173

Torgerson, P. (2002): Transmission dynamics of taeniid parasites in animal hosts. In: Craig, P.S. and Pawlowski, Z.S. (eds.), Cestode zoononoses: echinococcosis and cysticercosis, an emergent and global problem. IOS Press, Amsterdam, The Netherlands, pp.221-235

Umur, S. (2003): Prevalence and Economic Importance of Cystic Echinococcosis in Slaughtered Ruminants in Burdur, Turkey, *Journal of Veterinary Medicine*, **50**: 247-252.

Urquhart, G.M., Armour, J., Duncan, J.L., Dunn, A.M., Jenning, F.W. (1996): Veterinary Parasitology, UK, Black well Science, 2nd edn. pp.257 – 271.

WHO/OIE (2001): World Health Organization (WHO)/Office International des Epizooties (OIE) Manual on Echinococcosis in Humans and Animals Paris, France, pp. 1–265.

Wubet, M. (1987): A Preliminary study of Echinococoisis\Hydatidois in Hararge region. DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia.

Yemane, G. (1992): Preliminary study on Echinococoisis\Hydatidois in Ruminants slaughtered at Nazreth abattoir. DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debrezeit, Ethiopia.

Yilkal, A. (1989): Hydatidosis in cattle, sheep, pigs; *Cysticercus tenuicollis* in sheep around Dessie and the efficacy of *Hagenia abyssinica* (koso) on *Taenia hydatigena*. DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia.

Yimer, E., Beyene, M., Woldemichael, T., Zewdie, B. and Bekele, A. (2005): Prevalence of hydatidosis in animals slaughtered at Addis Ababa abattoir and dog echinococcosis in Addis Ababa city. *Ethiopian Veterinary Journal*, **9**: 151-154.

Yong, W. K., Heath, D. D. and Van Knapen, F. (1984): Comparison of cestode antigens in an enzyme-linked immunosorbent assay for the diagnosis of *Echinococcus granulosus*, *Taenia hydatigena* and *Taenia ovis* infections in sheep. *Research in Veterinary Science,***36**:24-31.

Zhang, W., Jun Li., P. and McManus, D. P. (2003). Concepts in Immunology and Diagnosis of Hydatid Disease. *Clinical Microbiology Reviews*, **16**:18-36.

8. ANNEXES

Annex 1. Post mortem inpection Recording Format

No.	Date	Species	origin	Age	Organ/location						Indvidual cyst count				Tot.cyst count
1					lv	lg	hrt	car	O+M	OS	Ct	Cov	hc	Coce	
2															
3															
4															
5															
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* lv=liver, lg=lung, hrt=heart, car=carcass, O+M=omentum and mesentry, Ct= *Cysticercus tenuicollis, Cov=cysticercus ovis*, hc=hydatid cyst, Cce=*Coenurus cerebralis*

Annex 2. Dentation formula to estimate the age of the goat (Mike Steel, 1996)

Age group	Teeth condition
Kid under 1 year	Eight sharp incisors
Yearling (1 – 2 years)	Central pair of baby teeth replaced by permanent ones
Young adult (3 - 4 years)	4 permanent teeth
Adult (4 – 5 years)	8 permanent teeth
Older adults >5 years	Worn teeth and some missing

Annex 3. Estimation of the age of sheep based dentation formula (Gatenby, 1991)

Permanent incisors	Age of the sheep
None	Less than 1 year and 3 months
1 pair	1 year & 3 months up to < 1 year & 10 months
2 pairs	1 year 10 months up to <2 years 4 months
3 pairs	2 years 4 months up to 3 years
4 pairs	More than 3 years

9. CURRICULUM VITAE

I. Personal data

Name: Adem Abdella Hassen

Date of birth: October 2, 1963 E.C.

Place of birth: Oromia National Reginal State, West Hararge Zone, Ethiopia.

Marital status: Married

Religion: Islam

Profession: Veterinarian

Language (speaking and writing): Afan Orom Amharic, English.and Arabic

II. Educational background

Year in EC	Institution	Award
1972 - 1974	Masala elementary and Junior Secondary School	-
1975 - 1976	Chiro No.1. Junior secondary shool	-
1977-1980	Chercher Comprehensive secondary School	Ethiopian School Leaving Certificate
1981 - 1986	Addis Ababa University, Faculty of Vet. Medicine	Doctor of Veterinary Medicine (DVM)
1997-1998	Addis Ababa University, Faculty of Vet. Medicine	MSc in Tropical Veterinary Medicine

III. Work experience

1. 1987 – 1994 E.C. Woreda Veterinarian and Animal health team leader, Kuni werada Agricultural Development office.

2. 1995-1996 E.C Head, Mieso werada Agricultural office.

IV. Research output / Technical paper

1. Principle of Antimicrobial therapy in Veterinary Medicine, Seminar paper (1993).
2. Prevalence of Bovine and Ovine Fasciolosis arrond Ziway, Southern Shewa, Ethiopia. DVM thesis (1994).
3. Metacestodes of small ruminants: Prevalence at three export abattoirs (ELFORA, Hashim, Luna) Msc thesis (2006).

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10. SIGNED DECLARATION SHEET

I, the under signed, declare that the thesis is my original work and has not been presented for a degree in any university and that all sources of material used for the thesis have been duly acknowledged.

Name: Adem Abdella Hassen

Signature _____

Date of submission _____

This thesis has been submitted for examination with my approval as University advisor:

Dr. Getachew Tilahun _____

Matacestodes Of Smallrumints Prevalence At Three Export Abatt oirs (Elfora, Hashim & luna)

Adem Abdella