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STUDY ON THE PREVALENCE OF CYSTICERCOSIS AND HYDATIDOSIS IN CATTLE
SLAUGHTERED AT ADDIS ABABA ABATTOIRS ENTERPRISE, ADDIS ABABA,
ETHIOPIA
MSc Thesis

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Department of Microbiology Immunology and Veterinary Public Health
MSc Program in Tropical Veterinary Public Health

June, 2005
College of Veterinary Medicine and Agriculture, Bishoftu

STUDY ON THE PREVALENCE OF CYSTICERCOSIS AND HYDATIDOSIS IN
CATTLE SLAUGHTERD AT ADDIS ABABA ABATTOIRS ENTERPRISE, ADDIS
ABABA, ETHIOPIA



A Thesis submitted to the College of Veterinary Medicine and Agriculture of Addis Ababa
University in partial fulfillment of the requirements for the degree of Master of Science in
Tropical Veterinary Public Health

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College of Veterinary Medicine and Agriculture, Bishoftu

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As member of the Examining Board of the final MSc open defense, we certify that we have read and evaluated the Thesis prepared by: Bayissa Tesfaye entitled a study on the prevalence of cysticercosis and hydatidosis in cattle slaughtered at addis ababa abattoirs enterprise and recommend that it be accepted as fulfilling the thesis requirement for the degree of master of Science in Veterinary Public Health.

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DEDICATION

This thesis is dedicated to those who died, are dying and will die for truth.

STATEMENT OF THE AUTHOR

First, I declare that this thesis is my *bonafide* work and that all sources of material used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for an advanced (MSc) degree at Addis Ababa University, College of Veterinary Medicine and Agriculture and is deposited at the University/College library to be made available to borrowers under rules of the Library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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LIST OF ABBREVIATIONS

AAU	Addis Ababa University
AE	Alveolar echinococcosis
AIDS	Acquired Immune Deficiency Disease
b.wt	body weight
BMC	Botswana Meat Commission
CDC	Center for Disease Investigation and Control
CE	Cystic Echinococcosis
CI	Confidence Interval
CNS	Central Nervous System
CSA	Central Statistical Authority
CT	Computerized Tomography
DNA	Deoxyribonucleic Acid
DVM	Doctor of Veterinary Medicine
Ed.	Editor
ELISA	Enzyme Linked Immuno-sorbent Assay
ETB	Ethiopian Birr
IgA	ImmunoglobulinA
IgE	ImmunoglobulinE
IgG	ImmunoglobulinG
IHAT	Indirect Haemagglutination System
ILCA	International Live Center for Africa
m.a.s.l.	meter above sea level
HIV	Human Immune Deficiency Virus
MRI	Magnetic Resonance Immagin
Kcs	Czechoslovak crowns

List of Abbreviations (*Continued*)

MSc	Master of Science
NMSA	National Meteorology Service Agency
OIE	Office of International des Epizooties
OR	Odds Ratio
PCR	Polymerase chain reaction
PE	Polycystic echinococcosis
UK	United Kingdom
USD	United States Dollar
WHO	World Health Organization

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ABSTRACT

A cross-sectional study was conducted from November 2012 to April 2013 to determine the prevalence and characteristics of metacestodes in cattle slaughtered at Addis Ababa abattoirs enterprise, Ethiopia. In addition, a questionnaire was presented to the inhabitants of the city to determine their infection status as well as to identify factors predisposing them to infection. Out of the 410 cattle examined for the presence of metacestodes: 110 had *Cysticercus bovis* and 70 hydatid cysts. Therefore, the overall prevalence of bovine cysticercosis and hydatidosis was determined to be 26.83% (95% CI = 22.60-31.40) and 17.07% (95% CI = 13.56 – 21.07) respectively. Results of the study showed that origin, breed, age and body condition of the animal significantly affected the prevalence of cysticercosis ($P < 0.05$). Significantly less infection of *C. bovis* was observed in cattle from Borana (OR = 0.27; 95% CI = 0.14-0.52; $P = 0.000$) and Woalita (OR = 0.39; 95% CI = 0.20-0.72; $P = 0.003$) than in cattle from Arsi and in adult ≥ 5 years) (OR = 0.47; 95% CI = 0.30 – 0.74; $P = 0.001$) than in young animals (<5 years). Cattle that are crossbreed and medium body conditioned were 2.5 (95% CI = 1.12-5.59; $P = 0.025$) and 3.49 (95% CI = 1.79 – 6.78; $P = 0.000$) times more infected with cysticercosis than localbreed indigenous cattle and those with good body condition. Similarly, cattle from Borana were significantly less (OR = 0.31; 95% CI = 0.14 – 0.68; $P = 0.003$) infected with hydatid cyst than those from Arsi while Adult cattle (≥ 5 years) were highly (OR = 2.02; 95% CI = 1.08-3.78; $P = 0.028$) infected than young animals (<5 years). However, breed and body condition of cattle were insignificantly associated with the prevalence of

hydatid cyst ($P>0.05$). The heart, shoulder and masseter muscles were the most frequently *C. bovis* infected organs with an infection rate of 31.79%, 25.17% and 23.84% respectively. The Lungs and liver were found more frequently affected than the remainder with a respective proportion of 56.25% and 23.44% of infected organs in that order. Of the 400 *C bovis* collected and examined for viability 191 (47.75%) were alive while 209 (52.25%) were dead. out of 500 cysts collected and examined for the status of fertility, sterility, or calcification, 112 (22.4%) were calcified, 219 (43.8%) sterile, and 169 (33.8%) fertile. And out of 169 fertile cysts 58 (34.3%) were live whereas 111 (65.7%) dead. From a total of 110 interviewed persons, 70 (63.64%; 95% CI: 53.92%-72.60%) disclosed they have contracted infection. univariable logistic regression analysis of various characteristics, the proportion of infection with *T. Saginata* varied significantly between the two sexes, among the different age groups, religion, occupation, meat eating habits and uses of spices ($P<0.05$) whereas marital status and type of education were insignificant ($P>0.05$). Females were found less affected with taeniosis as compared to males (OR = 0.24; 95 CI = 0.11-0.55; $P = 0.000$). Among the different age groups considered, those between 15 and 26 years were 10.83 times (95%CI = 2.05-57.27) more infected than those below 15 years. Likewise, those 27-40 years and above 40 years were 14.17 times (95% CI = 2.71-74.11) and 6.67 times (95% CI = 1.05-42.43) more infected than those under 15 years of age. From the two religious groups, Christians' were more prone to beef tapeworm infection than Muslims (OR = 4.57; 95 CI = 1.56-13.41; $P = 0.006$). High risk groups that have frequent exposure too cattle meat and their products showed 8.17 (95% CI = 3.25-20.54; $P = 0.000$) times, raw meat eaters 14.29 (95% CI = 5.92-34.42; $P = 0.000$) times times and spice users 2.59 (95% CI = 1.17 – 5.76; $P = 0.019$) times higher infection than the low risk groups, cooked meat eaters and those who do not use spice. Drug inventory on five drug shops and pharmacies between the year 2009 and 2012 revealed that 481,320 doses of taenicial drugs were sold that worth 10,120,112 Eth. Birr and niclosamide (tablet), mebendazole and praziquantel were the most frequently sold drugs. In conclusion, prevention of metacestode infection via through proper process of freezing, boiling or destruction infected carcasses and offals, regular deworming of dogs and creation of public health awareness is recommended.

Key words: *Cysticercosis*, Cattle, Hydatidosis, Prevalence, Addis Ababa, Ethiopia.

1. INTRODUCTION

Ethiopia's livestock productivity, despite its huge population size, remains marginal due to prevalent diseases, malnutrition and management constraints. Parasitism represents a major setback to the development of the sub-sector. However, data on epidemiology, economic loss and relative hierarchy of individual parasitic infections are hardly available, which otherwise were of paramount importance to determine the type and scope of control intervention to be envisaged (Jobire *et al.*, 1996).

Bovine cysticercosis/cysticercosis *T. saginata*, refers to the infection of cattle with metacestodes of the human tapeworm (Radositis, 1994; Oladele *et al.*, 2004). Ingested eggs develop into cysticerci, which can often be detected during meat inspection at the routinely inspected localization sites of the parasite, including heart, skeletal muscle and diaphragm (Gracey and Collins, 1992). Differences in geographical isolates of the parasite and in the breed and age of cattle have been suggested as possible factors affecting the distribution of *Cysticercus bovis*.

Globally, carriers of bovine taeniosis are 77 million and about 40% of them live in Africa. In relation to developed countries even if the disease has a very low prevalence, the problem with removal and treatment facilities in their sewage system plays a role in the distribution of eggs (Frolova, 1985), since it is shown that the egg can survive in sewage (Arudkil and Adolph, 1980). The larvae of *T. saginata* still cause significant problems in many parts of the world. In some countries the infection rate of cattle with *C. bovis* has increased. For example, under large scale management conditions a prevalence rate of about 50% (Eckert, 1996). Even though the parasite doesn't cause clinical disease in infected cattle, it is economically important especially in developing countries by hindering the export of live cattle and cattle products.

Financial losses can be considerable when large numbers of animals are affected, such as in feedlot. Most incidents arise as a result of direct exposure to proglottids shed from farm

workers, but have been some reports of large scale outbreaks resulting from sewage-contaminated feed or forage (Wayne, 2002). For that reason, *T. Saginata* /bovine cysticercosis is considered as an important public health and economic problem because of its consequence on human nutrition and economy of some countries (Wanzala *et al.*, 2003a).

Taeniosis due to *T. saginata* is a well-known disease in Ethiopia. The prevalence of the infection varies widely from 10 to 70% (Mamo, 1988).The disease has been reported by different travelers who came to Ethiopia in ancient times which were documented in medical history of Ethiopia (Pankrhust, 1990). Despite the fact that a large proportion of Ethiopian population frequently takes taenicidal drugs, there are limited systematic studies undertaken so far to evaluate the importance of *T. saginata* on the economic impact of the infection through the inventory of pharmaceutical shops.

At present, the most practical way of detecting cysticercosis is by post mortem inspection of the exposed predilection sites. Even though several studies were conducted on the prevalence of taeniosis based on abattoir survey, the lack of adequate information on the prevalence of taeniosis based on abattoir survey, the lack of adequate information on the prevalence of taeniosis in the main city of Ethiopia makes this study necessary to identify gaps between whether or not the prevalence of taeniosis is similar in different parts of the country for future improvement options and research focus.

Hence, this study was initiated with the following objectives:

- to determine the prevalence of bovine cysticercosis and hydatidosis on animals slaughtered at Addis Ababa abattoirs enterprise.
- to assess the situation of human *Taenia saginata* taeniosis in Addis Ababa city.
- to estimate the economic impact of the disease through inventories of pharmaceutical and drug shops.

2. LITERATURE REVIEW

2.1 Etiology

2.1.1 Taxonomic Classification

Bovine cysticercosis refers to the infection of cattle with metacestodes of human tapeworm (Oladele *et al.*, 2004; McFadden *et al.*, 2011). The unarmed beef tapeworm of human; *T. saginata*, and its metacestode, *Cysticercus bovis* belong to the class of cestoda, order cyclophyllidea, family Taeniidae and genus *Taenia* (Urquhart *et al.*, 1996).

Echinococcosis is a zoonotic infection caused by adult or larval (metacestode) stage of cestode belonging to the genus *Echinococcus* and the family Taeniidae. At present four species of *Echinococcus* are recognized, namely: *Echinococcus granulosus*, *E. multilocularis*, *E. oligarthus* and *E. vogeli*. The parasites are perpetuated in life cycles with carnivores as definitive hosts, which harbor the adult with egg producing stage in the intestine and intermediate host animals, in which the infective metacestode stage develops after per oral infection with eggs (Seimenis, 2003). Metacestodes may incidentally also develop in human causing various form of echinococcosis such as:

1. *Echinococcus granulosus* (causative agent of cystic echinococcosis)
2. *Echinococcus multilocularis* (causative agent of alveolar echinococcosis)
3. *Echinococcus vogeli* (causative agent of polycystic echinococcosis)
4. *Echinococcus oligarthrus* (causative agent of polycystic echinococcosis) (Soulsby, 1986).

2.1.2 Morphology

2.1.2.1 Adult Worm

Taenia saginata is ribbon-shaped, flattened, multisegmented and hermaphrodite. The body is divided into three distinct parts of scolex (head), neck and strobili (chain of proglottids). It measures 4-8 m rarely measures up to 15 m in length (Urquhart *et al.*, 1996). Anteriorly, the scolex (head) has four muscular suckers often unarmed, rostellum and hooks, the length and number of these being relatively characteristic of a species. A neck follows the scolex, this is followed by immature and then by mature reproductive segments, and finally gravid segments filled with eggs. Segment structure, although unreliable, can aid diagnosis. *Taenia* species cannot be differentiated by egg structure. The neck is short unsegmented with a germinal structure immediately behind the scolex, which continuously produces proglottids.

The number of proglottids is within a range of 700-1000 rarely reaching 1000-2000 (Urquhart *et al.*, 1996). The gravid segments are 10-20 mm long and are usually shed singly and may leave the host spontaneously or crawling about the body, clothes and beds of human beings. Self and cross-fertilization between and among proglottids is possible. The gravid proglottids are 15 mm to 35 mm long and 5mm to 7 mm wide filled with eggs, which detach from the strobila singly and leave the host via anus. This implies that coprological examination has a limited value in the diagnosis of *T. saginata* infection (Gebre Emanuel, 1997).

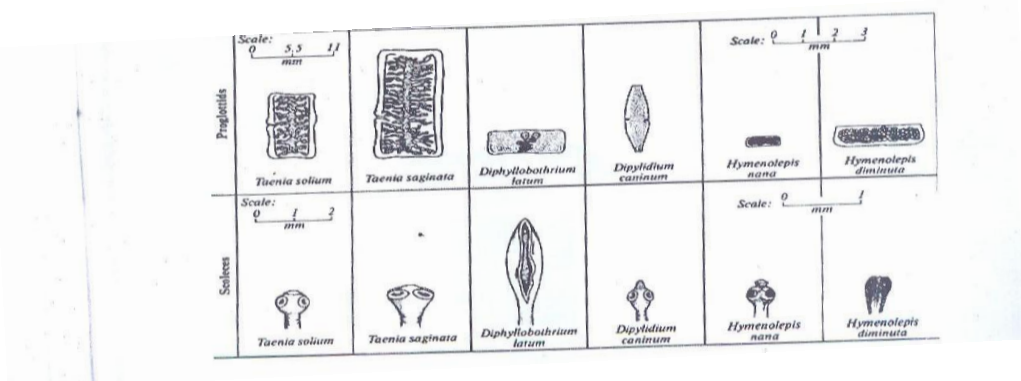


Figure 1: The scolex and proglottids of some cestodes.

Source: Wen *et al.* (1993).

An adult *Echinococcus* is of only a few millimeters long (rarely more than 7 mm) and usually has no more than six segments whereas species of *Taenia* can grow to several meters in length and consist of several thousand segments. Like all tapeworms, *Echinococcus* has no gut and metabolic interchange takes place across the syncytial outer covering the tegument (Soulsby, 1982). Anteriorly and adult *Echinococcus* possesses a specialized attachment organ, the Scolex that has four muscular suckers and two rows of hooks, one large and one small on the rostellum. The body or strobila is segmented and consists of a number of reproductive units (proglottids), which may vary, in number from two to six (Bowman, 1999). The adult worm is hermaphrodite with reproductive ducts opening at a common, lateral, genital pore, the position of which may vary depending on species and strain. There is a prominent girus sac, which may be horizontal or tilted anteriorly and the citellarium is globular. The uterus dilates after fertilization eventually occurring most of the terminal segment when the eggs are fully developed (Chandler *et al.*, 1961).

2.1.2.2 Egg

Taenid eggs passed in the faeces or discharged from ruptured gravid segments are subspherical to spherical in shape. The egg consists of hexacanth (six hooked) embryo (oncosphere), thick dark brown to yellow in color. There is an outer oval membranous coat, the true egg shell, which is voided the faeces. Inside the inner envelope develops into the embryophore, which is made of “Keratin” blocks and gives the egg its characteristic radiated appearance (WHO, 1983) and membrane thick and striated embryophore, and two oncospherical membranes. The mature ova are present only in the terminal 30-50 proglottids, and some immature ova can mature outside the host within about 2 weeks, whereas others fail to mature after two months. The egg is roughly spherical in shape and measures 30-50 by 20-30 micrometers (Urquhart *et al.*, 1996).

The eggs of *Echinococcus* are morphologically indistinguishable from those of other tapeworms of the genus *Taenia* (Charles, 1998). They are ovoid (30 µm-40 µm diameter) consisting of a hexacanth embryo (oncosphere first larval stage) surrounded by several envelopes, the most noticeable one being the highly resistant keratinized embryophore, which

gives the egg a dark striated appearance. The outer capsule quickly disappears once the eggs are liberated from the host.

2.1.2.3 Metacestode

Metacestodes consist of a fluid-filled bladder with one or more invaginated protoscoleces. These 'bladder worms' are each contained within a cyst wall at the parasite-host interface (Lloyd, 1998). The predilection site in the intestinal mucosa is the proximal part of the jejunum (Gracey and Collins, 1992; OIE, 2004).

The cysticerci are formed over a period of 3-4 months after the egg is ingested and may remain viable in the intermediate host for up to 9 months or even up to the entire life of the host (WHO, 1983). The larval stages, or metacestodes, are found in all striated muscles of the intermediate hosts (Dunn, 1978). *Cysticercus bovis* is a small (Pea sized oval in shape) (OIE, 2001), grayish white, about 1 cm in diameter and filled with fluid in which the scolex is often clearly visible. As in the adult tapeworm, it has neither rostellum nor hooks. Although the cyst may occur anywhere in striated muscle, the predilection sites, at least from the viewpoint of routine meat inspection, are the heart, the tongue and masseter and intercostals muscles (Urquhart *et al.*, 1996; Smith, 1994).

The metacestode (second larval stage) of *Echinococcus* 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. The structure and development of the metacestode differs between the four species of *Echinococcus* (Charles, 1998).

Table 1: The characteristic features for the differentiation of *Taenia saginata*, *T. solium* and *T. asiatica*.

Characteristics	<i>T. saginata</i>	<i>T. asiatica</i> *	<i>T. solium</i>
Intermediate host	Cattle, reindeer	Pig, wild boar, cattle, goat, monkey	Pig, wild boar
Development site	Muscle, viscera	Mainly liver	Brain, skin, muscle
Scolex			
Sucker	4	4	4
Rostellum	Absent	Present	Present
Hooks	Absent	Present	Present
Mature proglottids			
Ovary	2 lobes	2 lobes	3 lobes
Vaginal sphincter	Present	Present	Absent
Egg size	40 × 50 µm	33 × 28 µm	40 × 50 µm
Gravid proglottids			
Uterine branches	23(14-32)	17(12-26)	8(7-11)
Passing of proglottids	Spontaneous, singly	Spontaneous, singly	Passively in groups
<i>Cysticercus</i> size	10 mm	1320 × 3129 µm	20 × 10 mm

Source: Adapted from Eom and Rimn (1993) and Smith (1994).

2.2 Life Cycle

The life cycle of *T. Saginata* is indirect where the definitive host is human and intermediate host is cattle (Urquhart *et al.*, 1996). Human is infected by the ingestion of raw or undercooked parasitized meat (Biru, 1984; WHO, 1983). Only fresh viable *C. bovis* cysts are infective for man (Gracey *et al.*, 1999). An infected human passes millions of eggs daily either free in the stool or as intact segment and each containing 250,000 eggs (Urquhart *et al.*, 1996), and these can survive on pasture for several months. After ingestion by susceptible bovine, the

oncosphere remains unaffected in its passage through the first three compartments of the stomach. On reaching the abomasums, it will be attacked by pancreatic secretion on reaching the duodenum and it disintegrates releasing the oncosphere (Smith, 1994). The oncosphere travels via blood to striated muscle where it encysts and matures to be infective to man in about 12 weeks. Once in the animal body, the eggs hatch and the larvae migrate their way into muscle tissue, including that of the heart and other organs (Figure, 2). The irritated tissue reacts by forming cysts around the invaders. Fortunately, cattle cannot transmit the diseases among themselves. However, they can ingest eggs from human sewage and excrement that have contaminated water and feed, or by licking soiled utensils and workers' hands and clothing. Eating cyst-laden and incompletely cooked meat, on the other hand, may infect humans. Like cattle, human cannot spread cysticercosis to their own species (WHO, 1983). Finally, human beings become infected by ingesting raw or inadequately cooked meat, which contains viable cysts (Dunn, 1978).

An infected person can shed as many as 1 million eggs each day. Ingesting contaminated pasture infects bovine. The tapeworm thrives in the small intestine of humans. As it matures it produces segments that each contains about 100 thousand eggs. The segments break off and move to the outside either in the faeces or by migration through the anus.

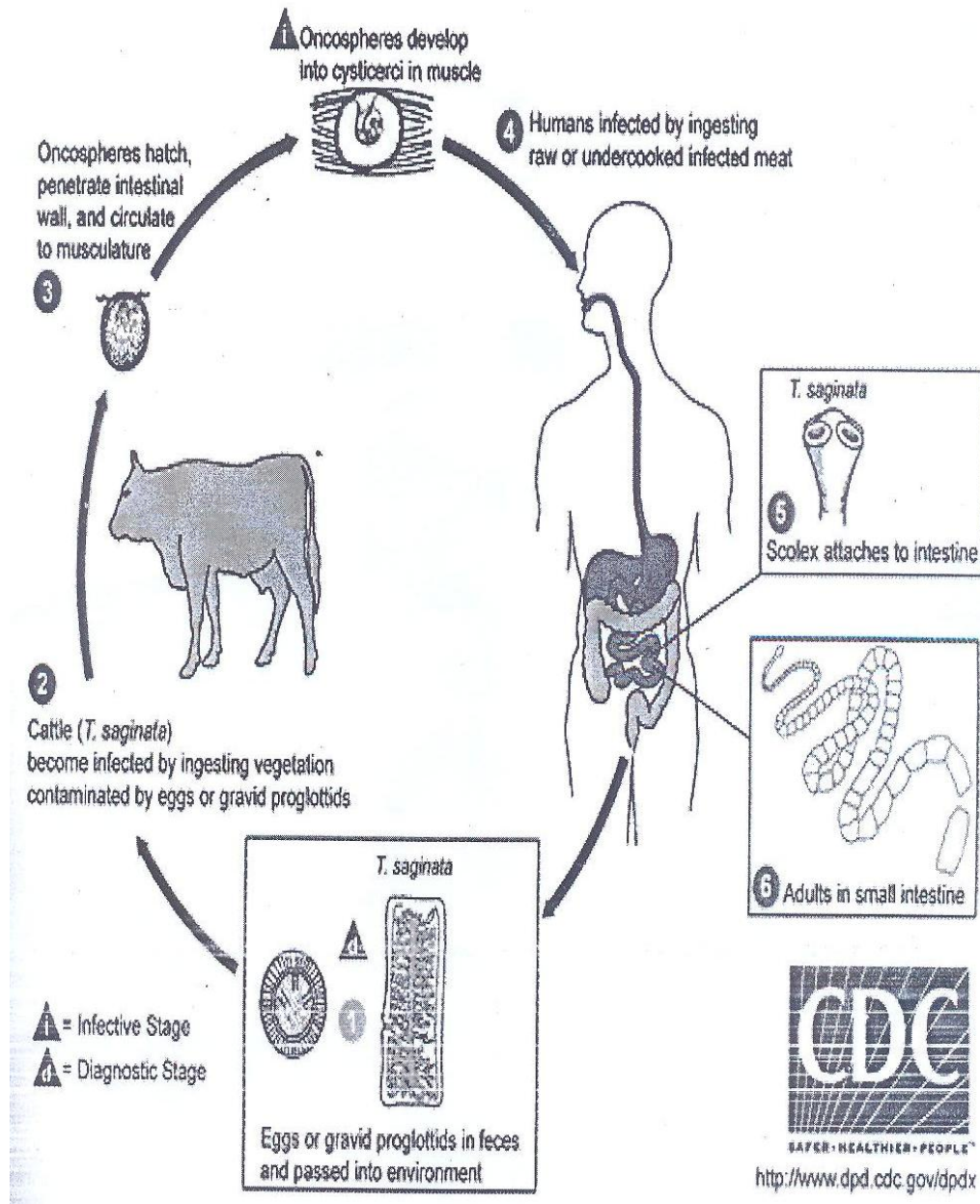


Figure 2: The life cycle of *Taenia Saginata*

Source: CDC (2000)

Echinococcus spp require two mammalian hosts for completion of their life cycle (McManus, 2006). Segments containing eggs (gravid proglottids) or free eggs are passed in the faeces of the definitive host, a carnivore then; the eggs are ingested by an intermediate host in which the metacestode stage and protoscolices develop. The life cycle is completed if such an

intermediate host is eaten by a suitable carnivore (Chandler *et al.*, 1961). Figure 3 illustrates the life cycle of *E. granulosus*.

Eggs are highly resistant to environmental influences and can remain infective for many months or up to about 1 year in a moist environment at lower ranges of temperatures (4 to 15°C). The eggs of *Echinococcus* are sensitive to desiccation. At a relative humidity of 25%, eggs of *E. granulosus* were killed within 4 days and at 0% within 1 day. Heating to 60°C-80°C killed eggs of *E. granulosus* in less than 5 minutes. On the other hand, *Echinococcus* eggs can survive at freezing temperature (Reinecke, 1989).

The intermediate hosts, represented by a wide range of mammals acquire the infection by the ingestion of eggs. Following the action of enzymes in the stomach and small intestine, the oncosphere is released from the keratinized embryophore (Bowman, 1999). Bile assists in activating the oncosphere, which penetrates the wall of the small intestine. Penetration is then aided by the hook movements, and possibly by secretion, of the oncosphere. The oncosphere is passively transported to the liver, lungs and a few may be transported further to the kidneys, spleen, muscles, brain or other organs. All mammals (including man) in which metacestodes of *Echinococcus* species develop after infection with eggs are being referred to as intermediate hosts (Azizi *et al.*, 2000). From the epidemiological point of view, it might be useful to differentiate between intermediate hosts, which play a role in the perpetuation of the cycle, and aberrant or accidental hosts which represent “blind alley” for the parasite as the latter are not involved in disease transmission. This may be because metacestode stages do not become fertile in these hosts or because such hosts do not interact in the transmission cycle. With a few rare exceptions humans belong to the group as “aberrant hosts” (Smith, 1994).

Once the oncosphere has reached its final location it develops into the metacestode stage. It may take several months before protoscolices are produced (fertile metacestode).

There may be several thousand protoscolices within a single cyst of *E. granulosus* or an aggregation of vesicles of *E. multilocularis* (Grant and McManus, 2003; Eckert and Deplazes, 2004; Parija, 2004). Each single protoscolex is capable of developing mature adult worm. Not all metacestodes produce protoscolices (sterile metacestode). When protoscolices are ingested

by a suitable definitive host, following the action of pepsin in the stomach, they evaginate in the upper duodenum in response to a change in pH, exposure to bile and to increased temperature. They then develop to the sexually mature adult tapeworm approximately four to six weeks after infection, depending on the species and strain, and on the susceptibility of the host (Chandler *et al.*, 1961).

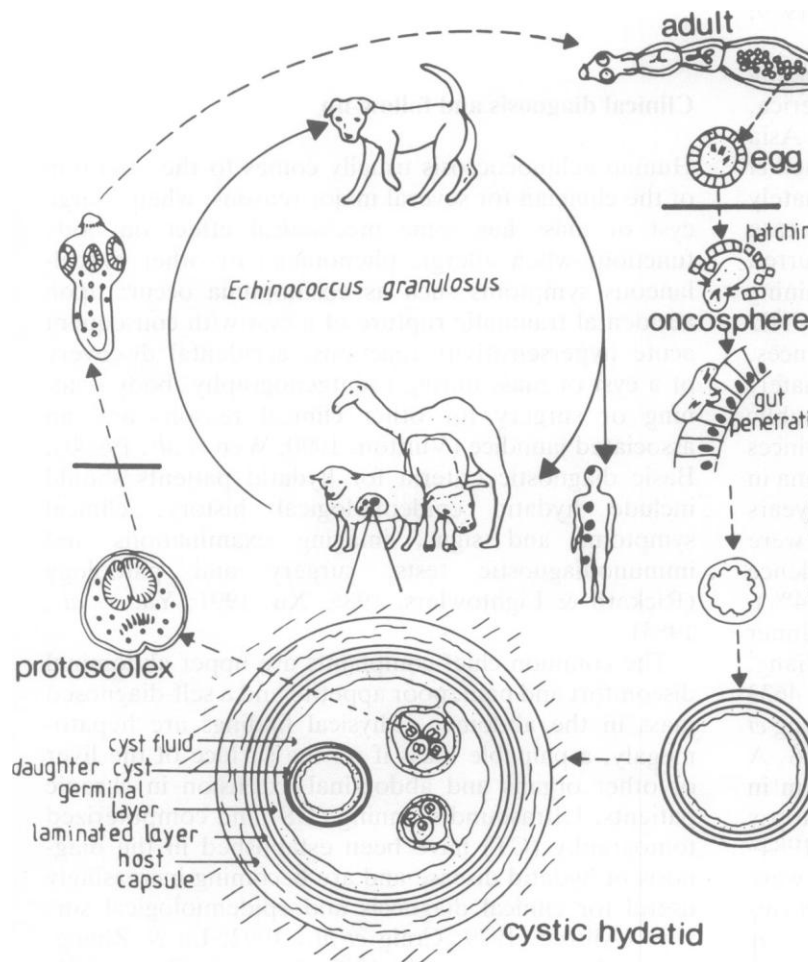


Figure 3: Life cycle of *Echinococcus granulosus*.

Source: Wen *et al.* (1993).

Hydatid cysts grow slowly, usually takes several to years to develop to a size where they may cause disease and symptoms in animals. Fertile cysts may occur within about 6 months in mice, 10-12 months in pigs, but about 2-4 years in sheep (but only 50% of *E. granulosus* cysts are fertile by 6.65 years). Cysts are rarely fertile in cattle in most countries, except where the cattle strain is present (WHO/OIE, 2002).

The life span of cysts of *E. granulosus* can be very long/example 16 years in horses and 53 years in man. Hydatid cysts frequently localize in the liver and lungs (Soulsby, 1982). However, they can also develop in either internal organs including the central nervous system, the skeletal muscles and in the marrow cavity of bones. The cysts of *E. granulosus* vary greatly in size and shape (typically unilocular, but sometimes multilobed or multilocular) and may present in large numbers in one or several organs (Thompson, 1979).

It has been postulated that symptoms experienced by humans infected with hydatid cysts may also occur to the same degree in infected animals. However, such symptoms may be overlooked, especially in the flock or herd situation. The development of pathological changes is related to various factors, such as the organs involved, the intra organ site and size of the cysts, the cysts number and their interaction with adjacent structures, particularly with bile ducts, the vascular system, and the bronchial tree. The meracestode stage of *E. granulosus* may cause severe forms of not only in human but also in animals (for example in horses). Anaphylaxis has been induced experimentally in sheep with hydatid cysts fluid, but sudden death in sheep or other animals ascribed to *Echinococcus* infection has never been recorded (Thomson *et al.*, 1985).

2.3 Epidemiology

Human feeding habits modes of life are responsible for the spread of *T. saginata* infections. Man's customs and traditions of consuming raw, sun-cured, inadequately cooked beef dishes like Steak tartar in Europe, *Shish Kebaba* and *Tikka* in India, *Shashlik* in the former USSR, *Ihab* in Thailand, *Yukhoe* in Korea and *Kourt* and *Kitffo* in Ethiopia containing viable bladder worms perpetuate human infection. Cattle are infected by ingestion of pasture and drinking water contaminated with *T. saginata* eggs (Frolova, 1982; Teka, 1997).

- Man's indiscriminate defecation.
- The use of sewage effluents and sludge as fertilizer on pasture, the use of immigrant labor from countries with high prevalence of infection in feedlots.

- Scavenger birds (Seagulls), earthworms, dung beetles, blowflies, oribatid mites, flooding water, etc.
- Age of the animal (Fertig and Dorn, 1985; Smith, 1994).

Cattle are the preferred intermediate hosts and humans are the only final hosts of *T. saginata*. Cattle of all ages are susceptible; however young age groups are more susceptible. Parasitism is sometimes observed in other ruminants (sheep, goats, antelops, gazelles, buffaloes) but *Cysticercus* development is unlikely. Man cannot spread taeniasis to his own species. Management of animals in their natural environment predisposes them to infection. Cattle grazing communally have a higher risk of picking up *T. saginata* eggs since they are frequently in contact with human feces compared to commercial herds, the risk of cattle coming into contact with *T. saginata* eggs is much higher when cattle are at pasture (Harrison and Sewell, 1991). In developing countries are readers on extensive scale, human sanitation is poorly developed which makes the incidence of *T. saginata* infection in humans very high. Calves are infected usually in early life, often with in the first few days after birth from infected stockmen whose hands are contaminated with *Taenia* eggs (Fertig and Dorn, 1985; Maedia *et al.*, 1996).

The parasite population of *Echinococcus* consists of three subpopulations: these are adults in the definitive host, larvae (metacestodes) in the intermediate host and eggs in the environment (Eckert and Deplazes, 2004; Radfar and Iranyar, 2004). The first step in understanding the transmission dynamics and problems of control of any members of this family is to determine the contribution made by the parasite and each host population to its stability. The second step must be to evaluate the role of intrinsic, and socio-economic factors in modifying this stability. The third step involves quantifying the equilibrium steady state of the whole system in each socio-ecological situation (Urquhart *et al.*, 1996). *Echinococcus granulosus* has an overdispersed distribution that fits a series of negative binomial distributions in both hosts, with only a small number of animals harbouring large number of worms or larvae. There is neither a "crowding" effect nor parasite induced host mortality, and this distribution does not contribute to the regulation of either adult or larval sub-populations.

The prepatent period is similar for all three species, potency being reached in dogs between 6 and 12 weeks. The larvae of *E. granulosus* grow slowly in sheep with only 50% reaching fertility by 6.65 years. The parasite's major contribution to the transmission dynamics is its biotic potential. The generally reported mean worm burden for *E. granulosus* in its dog-sheep life cycle is about 200-400 (Charles, 1998). However, with such highly susceptible animals as Turkana dogs in Kenya and dingoes in Australia, very high worm counts may be present in the majority of animals. With *E. multilocularis*, the time required to reach patency is about 28 days and the time taken to reach fertility in some dets may be only 60 days. There are also large variations in worm burdens of *E. multilocularis*. For example, that in arctic foxes (*Alopex lagopus*) in Alaska is two orders of magnitude greater than that in the red fox (*Vulpes vulpes*) in Dakota (Soulsby, 1982).

2.4 Clinical Manifestations

2.4.1 Taeniosis and cysticercosis

In man, there are usually no clinical disturbances except for pruritis ani, the patient being aware of discomfort in the perianal region. *T. saginata* taeniosis is a non-fatal infection in man caused by the adult meat tapeworm, *T. saginata* (WHO, 1983). Humans seldom show symptoms, but in some cases suffer abdominal pain, nausea, debility, weight loss, flatulence and diarrhea, or constipation may occur. A patient may have one or several of those symptoms. A high percentage of patients experience gastric hypo secretion (Pawlowski and Schultz, 1972). *Taenia saginata*, like all other human helminthes, may induce variable symptoms or may cause an unrecognized infection. However, asymptomatic *T. saginata* infection may within a short time, change into a life-threatening condition when proglottids are vomited and aspirated or when proglottid enters the appendix (WHO, 1983).

Most cases of bovine cysticercosis are acquired in the early calf hood, particularly from birth to 28 days (Gracey *et al.*, 1999). According to Urquhart *et al.* (1996), the presence of cysticerci in the muscles of cattle under natural conditions is not associated with clinical signs. However, experimentally infected calves dosed with massive *T. saginata* eggs developed

severe myocarditis and heart failure associated with developing cysticerci in the heart and the disease in animals is featured by absence of clinical manifestations on matter the degree of infection. It has no serious harmful effects on infected animals. Its importance is economic, particularly regarding exports. Presence of cysticercosis in meat affects exports. The significance of its impact in meat trade is increasingly becoming important in view of the drastic measures and very strict regulations of importing countries. In cattle, it is mainly the young from the age of 2 months to 4 months of years, which are infested. This is attributed to an inherent immunological deficiency in the young (Feseha, 1995).

2.4.2 Hydatidosis

In man hydatidosis/cystic echinococcosis results from infection with *E. granulosus* or *E. multilocularis*. They occur simultaneously in large endemic areas. The initial phase of primary infection is always asymptomatic, and small (<5 cm) well encapsulated cysts located in organ sites, where they do not induce major pathology, may remain asymptomatic for many years or permanently. In two Italian series with 420 and 424 patients, 38% and 60% of all cystic echinococcosis cases were asymptomatic, both this rate may be lower in other regions (WHO/OIE, 2002). After an undefined incubation period of several months or years, the infection may become symptomatic if cysts exert pressure on adjacent tissue and induce other pathological events. Sudden symptomatology may be due to spontaneous or traumatic cysts rupture.

The clinical effects of hydatidosis disease in intermediate hosts have been reviewed in detail by (Kaufmann, 1996). It is well known that the infection of animals with cysts of *E. granulosus* may be asymptomatic during the whole life span of the hosts.

Two clinical forms of echinococcosis are known to occur in animals:

- The intestinal infection with adult or immature stages of *Echinococcus* spp. and
- The infection of internal organs of intermediate or aberrant host animals with the metacestode stages (Chandler *et al.*, 1961).

Intestinal echinococcosis occurs in various species of carnivores as definitive hosts without causing any major ill effects to the host. The method used until now for surveys of the *E. granulosus* infection in dog population is arecoline purging (average sensitivity of 65%-78%) (Thompson, 1979; WHO/OIE, 2002). Copro-antigen detection by ELISA (CA-ELISA), which is easier to perform, may replace this method in the near future (WHO/OIE, 2002). In the small intestine, the *Echinococcus* parasites deeply between the villi into the crypts of lieberkuhn attachment with the suckers and rostellum hook to the epithelium. This intimate parasite-host relationship normally does not cause significant pathology. Minor changes may occur, such as flattening of epithelial cells slight cellular infiltration of the mucosa and increased mucus production.

If cattle are infected with the cattle strain, cysts are predominantly located in the lungs. Less frequently, cysts have been recorded in the spleen, heart, brain and the marrow cavity of bones. Multicystic structures, composed of several smaller vesicles, are not common in cattle and have repeatedly been misidentified as the metacetode stage of *E. multilocularis* (Thompson *et al.*, 1983).

2.5 Diagnosis

Adult cestodes can be expelled from human using and an antehelminthcs followed by a saline purgative and are identified based on scolex and proglottid morphology (OIE, 2004). In human beings, the diagnosis is established by examination of the eggs in the stools or gross examination of the proglottids or segments passed in the stool (Ghai, 2000). Diagnosis is based on symptoms, faecal examination and rectal swabs, although it is difficult to discover the disease during the first 3 months. A person should not be considered uninfected before having three negative tests completed over a 2-3 day intervals. In animals, arecoline purgation has been useful; again, the recovered tapeworms are identified morphologically (OIE, 2004).

It is difficult in live animals to diagnose the presence of *C. bovis* in the muscles. Thus diagnosis can be performed only at postmortem examinations by direct observation of *C. bovis* in the muscles (Gracey *et al.*, 1999; Biru, 1984). Taeniosis is most difficult to diagnose during the first 3 months of infection, before the eggs are produced and the proglottids discharged

(WHO, 1983). Since there is no characteristic clinical picture of infection, the diagnosis must be based on laboratory findings of stool examination, serology and skin tests to determine whether a tapeworm infection exists. Confirmatory diagnosis is made by examination of the scolex or those proglottids that show typical morphological characteristics (Pawlowski and Schultz, 1972). Eggs are distinguishable by morphological feature on; examination should be repeated if the results are negative (Hendrix, 1998). Recently researchers are suggesting PCR standardization that can be applied on human stool samples for taeniosis diagnosis by the extraction of deoxyribonucleic acid (DNA) from the sample (Nunes *et al.*, 2003).

Live cattle show on symptoms, so that it becomes extremely important to identify the cysts during meat inspection. A previous history of infestation on the animal premises also acts as a valuable diagnostic tool. Serological tests are also available to detect the disease in live animals.

The IHAT with 100% sensitivity and 91-100% specificity can be used as a diagnostic test for epidemiological survey, to map infected and disease free areas and to estimate the natural prevalence of the disease (Nigatu Kebede, 2004).

2.5.1 Diagnosis in living animals

- Safety precaution: handling of material containing viable eggs *E. granulosus* represents risk for humans. Therefore, special safety precaution has to be observed.
- Detection of eggs and proglottids: the *E. granulosus* infection in candies cannot be diagnosed by microscopic egg detection in faecal samples because these eggs are morphologically indistinguishable from those of *E. multilocularis* and the *Taenia* species.
- Eggs can be detected in faecal samples using routine flotation or on the perineal skin using clear adhesive tape, which is pressed to the skin, transferred to a microscopic slide and examined. Proglottids of *E. granulosus* spontaneously discharged by dog and detected mostly on the surface of faecal samples may allow a correct morphological diagnosis, if they are in good condition (Charles, 1998).

2.5.1.1 Arecoline purging

The standard method currently used for surveys of *E. granulosus* infection in dog populations is arecoline purging. It involves the application of arecoline to dogs and the examination of faecal material discharged after purging. Arecoline is the chief alkaloid of the *Areca nut*, the seed of *Areca catechu*.

Arecoline hydrobromide is a parasympathomimetic drug with a major action on the smooth muscle of the small intestine, as well as paralyzing the worm itself. The subsequent purgation carries the worms out with the faeces. For this activity, the drug must be given by the oral route or occasionally per rectum (WHO/OIE, 2002). Dose rates have varied between 1.75 mg/kg and 3.5 mg/kg b.w. and were suitable for most dogs (Thompson, 1979). Doubling or having the dose rate does not increase efficacy, but the former may cause excessive vomiting. The drug may be given in tablet or liquid form.

2.5.1.2 Immunodiagnosis

Immunodiagnosis involves the following alternative approaches: Detection of parasite antigens in faeces (copro-antigen) and serum antibody detection. Copro-antigen detection by (ELISA): several groups have described ELISA's for the detection of copro-antigens released by cestodes, including *Taenia* species of dogs and humans (WHO/OIE, 2002).

In several studies detection of *E. granulosus* coproantigens was highly specific, and significant cross-reactions have not been observed in experimental *Taenia* spp. using faecal samples from necropsied stray dogs/with *Taenia* spp. or intestinal nematodes or helminth-free involving 183 animals over all specificity was 97% (Smith, 1994). When *E. granulosus* worm burdens are greater than 100, the sensitivity of copro-antigen tests approaches 92% to 100% when postmortem worm counts or arecoline purge counts are below 100 worms the sensitivity is variable (29%-70%) with the current copro-antigen ELISA's. Despite an overall sensitivity for copro-antigen tests of 63% to 77% more than 90% of the biomass of adult *E. granulosus* present in a target dog population will be detectable (WHO/OIE, 2002).

For copro-antigen tests, faecal samples are directly taken from rectum or the ground and mixed with buffer solution. Such samples can be stored for some days in the refrigerator or they may be deep frozen (-20°C) until use. The copro-antigen test can be used for identifying pregnant bitches, old dogs and young puppies (Smith, 1994).

Serum antibodies (IgG, IgE) can be detected in experimental canine echinococcosis using an *E. granulosus* protoscolex antigen preparation in ELISA and *E. granulosus* anti body could be detected by 2-3 weeks post infection. However, while sensitivity was reported to be high (73%) for natural canine *E. granulosus* infection in southeast Australia, there was no correlation with worm burden. Further application of the *E. granulosus* protoscolex ELISA in endemic areas of Kenya and Uruguay indicated poor correlation (sensitivity 35% - 40 %) with positive worm identification and necropsy.

2.5.1.3 Serum antibody detection

Serum antibodies (IgG, IgA, IgE) can be detected in experimental canine echinococcosis using an *E. granulosus* protoscolex antigen preparation in ELISA and *E. granulosus* antibody could be detected by 2-3 weeks post infection. However, while sensitivity was reported to be high (73%) for natural canine *E. granulosus* infection in southeast Australia, there was no correlation with worm burden. Further application of these *E. granulosus* protoscolex ELISA in endemic areas of Kenya and Uruguay indicated poor correlation (sensitivity 35%-40%) with positive worm identification at necropsy (WHO/OIE, 2002).

2.5.1.4 Diagnosis at necropsy

The following approaches are indicated for the diagnosis of *E. granulosus* infection of carnivores at necropsy.

a) Collection of Material

The small intestine should be removed as soon after death of the definitive host as possible, tied at both ends and placed in a numbered plastic bag metal container. The material can be

deep frozen until examination at -20°C or at 70°C to 80°C. At the lower temperatures, the eggs of *E. granulosus* are killed. The injection of fixative (4°C-10°C formalin) into the lumen of the intestine is a further option for material preservation. However, it is not recommended, fresh material should be used whenever possible (WHO/OIE, 2002).

b) Necropsy procedure

Several techniques are used for the diagnosis of the *E. granulosus* infection at necropsy.

Direct examination of the intestine: The intestine can be divided into several sections, and each is placed on a tray, opened with a scissors and immersed in physiological saline solution at 37°C. Worms adhering to the intestinal mucosa can then be directly counted with the use of a hand magnifying lens or stereoscopic microscope. An initial washing and transfer to another tray may assist, when the intestinal contents with observations of the intestinal wall. This method has disadvantages, because small number of worms may be overlooked and, these may escape detection (Soulsby, 1982).

Sedimentation and counting technique: Where accurate worm counts are required, the best method is to divide the fresh and unfixed intestine into three more sections. Open each section along its length and then immerse each in a large beaker in physiological saline solution at 37°C for 30 minutes which facilitates the releases most of the sediments.

2.5.2 Diagnosis in humans

The process of diagnosis of Cystic echinococcosis in individual patients goes through various steps as follows:

- Suspicion on clinical ground or upon screening.
- Confirmation by imaging and identification of characteristic or suspicious cyst structure.
- Confirmation by detection of specific antibodies with Immunodiagnosis test (ELISA, IFAT, and IMMUNOBLOT).

- In doubtful cases diagnostic punctures may be considered, if it is not contraindicated.
- Material obtained by biopsy puncture or surgery can be examined hydrated fluid for *Echinococcus* protoscolices or hooks, protoscolices for DNA by PCR, antigen from sterile cyst and wall material for characteristics structures by histology.

In many cases, a diagnosis can be made by detecting the characteristic structure and size of *E. granulosus* cysts visualized by various imaging techniques, including ultrasonography (US), Computed tomography (CT), standard radiology (X-RAY) and magnetic resonance imaging (MRI) in specialized centers (WHO/OIE, 2002). Introduction of “US” has improved both the diagnosis of cystic *Echinococcus* and the understanding of the natural history of the disease. Rarely characteristic hooks or protoscolices may be found in sputum, bile, stool, or urine after spontaneous rupture of the cysts in lungs, liver or kidneys (WHO/OIE, 2002).

The direct diagnosis can also be made by macroscopic identification of the structure and size of *E. granulosus* cysts obtained by surgery and or by histological examination of the parasite tissue, available after surgery or biopsy. More sophisticated techniques in direct diagnosis include finding of specific *E. granulosus* antigen (antigen 5) in the fluid from sterile cysts or DNA markers in the cysts fluid or parasite tissue (by PCR) (Chandler *et al.*, 1961).

2.5.3 Differential diagnosis

It is difficult to differential *T. saginata* and *T. solium* by parasitological examination because their eggs are indistinguishable. Correct identification is important because the consequences of human infection by these two parasites are very different. *T. saginata* is relatively innocuous, since only the intestinal tapeworm phase occurs in man, whereas infection with *T. solium* has major health effects due to extra intestinal infection by the larval or cyst phase in the central nervous system (CNS) (WHO, 1983).

Differentiation of human *Taenia* species is based on the number of uterine branches present in well-preserved gravid proglottids or on the absence or presence of hooks in the scolex of the tapeworm (Mayta *et al.*, 2000). *C. dromedarius*, the metacestode of the hyaenae which is

twice as long as *C. bovis* measuring 12 to 18 mm in length, pearly white in color and possess double row of hooks on the lateral part of scolex. Hailu (2005) and Amsalu Demessie (1989) have reported this cyst in this country. The diagnosis of *Onchocerca dukei*, *C. bovis*, *Sarcocystis*, and *C. dromedary* can be confusing. There is a possibility for these parasites to co-exist on a single carcass. White soft nodules are formed by *Sarcocystis* measuring 4 to 6mm long in the esophagus and sometimes in other muscle. *O. dukei* measures 3 to 6mm in diameter which form intra-muscular and subcutaneous nodules, that are firm to touch and reveal worms surrounded by pus when sectioned (CTA, 1989). Fat globules and lesions of actinobacillosis (especially in the tongue) must be considered (Gracey *et al.*, 1999).

A number of characteristics are employed for differentiation such as scolex in the adult, *Cysticercus*, number of the lateral branches of the uterus in the gravid proglottids, ovary, and vagina, site of *Cysticercus* development, preferred intermediate hosts and egg size. However, some of the above mentioned characteristics are not fully reliable. For example, an egg of *T. solium* and *T. saginata* can't easily be distinguished since the scolex of intestinal tape worm remains in the gut even after treatment hence this is not always available for differentiation. A much-used criterion is the number of lateral benches of the uterus in the gravid proglottids, observed by simply pressing them between two glass slides and examined (Pawlowski and Schultz, 1972). Understanding the morphological differences between adult *T. solium* and *T. saginata* is of great clinical and epidemiological importance's to be able to distinguish between patients infected with *T. solium* and *T. saginata*. Sometimes the only material available is a few expelled proglottids that may be in poor state of preservation, in recent times the identification of the different *Taenia* species using multiplex PCR yielded differential products unique for *T. saginata*, *T. asiatica* and *T. solium* based on their molecular sizes (Yamasaki *et al.*, 2004). *T. solium* (the pork tapeworm) is smaller than *T. saginata* being up to 3-5 meters. The scolex has an armed rostellum bearing two rows of hoods; the number and size of hooks can aid differentiation of *Taenia* species (Table 1).

The salient feature of this third form of tapeworm is that it is an intermediate between the two classically known species, *T. solium* and *T. saginata*. Morphologically, the adult Asian *Taenia* is similar to that of the adult *T. saginata*, although the inconsistent presence of both marked

and unarmed rostellum on the scolex can differentiate the adult forms (Eom and Rim, 1993; Fan *et al.*, 1995); moreover, the intermediate host involved is not cattle, but swine (Fan, 1988; Fan *et al.*, 1995). In this context, the larval stage of the Asian taeniid exhibits a liver tropism, though other organs may also be affected (Eom *et al.*, 1992). In the intermediate host, the parasite has a cysticercus more similar to that of *T. solium* because the scolex possesses hooks; however, the cysticerci of the Asian *Taenia* are clearly smaller than those of *T. solium*. Cysticerci that have already lost their hooks may also be detected in swine (Fan, 1988; Eom and Rim, 1993; Fan *et al.*, 1995; Ito *et al.*, 1997). Jeon and Eom (2006) conducted a differential identification of *T. asiatica* and *T. saginata*, through the mapping of mitochondrial genomes and the sequencing of genes and found that designation of *T. asiatica* as a separate species from *T. saginata*. It has wart like formations on the larval bladder surface, posterior protuberance in the gravid proglottids and the large number of uterine twigs.

2.6 Treatment

For the treatment of the taeniosis there are a number of taenicial drugs available in the market. However, the drugs of choice in treating taeniosis are niclosamide (Niclosamide, Yomesan). Adult dose rate of 2000 mg is effective in damaging the worm to such an extent that a purge following therapy often produces the scolex (CTA, 1989 and WHO, 1983). Albendazole is a broad- spectrum antehelmithics of the benzimidazole class, which is effective against the larva and adult stages of cestodes and trematode (Yasmin *et al.*, 1995). Since dose of praziquantel i.e., (15 mk/kg) efficacies in diphllobothriosis, taeniarhynchiosis, and taeniosis made up 91.4, 98.5, and 100% respectively (Bronshstein *et al.*, 1993). Treatment with a single oral dose of praziquantel, 5 or 10 mg/kg is also effective. Alternatively, a single 2 g dose of niclosamide is given as 4 tablets (500 mg each) that are chewed one at a time and swallowed with a small amount of water (0.5 g is the dose for children 2 to 5 year old, 1 g for older children). Both drugs have cure rates of about 90%. Treatment can be considered successful when no proglottides are passed again within 4 months (CTA, 1989).

Table 2: Major taenicial herbs used in Ethiopia arranged in decreasing order of potency.

Local Name	Scientific Name	Parts Used
Bisana	<i>Croton macrosatchuys</i>	Bark*, Seeds
Enkoko	<i>Embelia schimperi</i>	Fruits*
Duba fire	<i>Cucurbita pepo</i>	Seeds*
Tosigne	<i>Thymus serrulatus</i>	Dn [#]
Kosso	<i>Hagenica abyssinica</i>	Flower*
Kechema	<i>Myrsine Africana</i>	Dn [#]
Keleum	<i>Maesa lanceolta</i>	Dn [#]
Serdo	<i>Cynadon dactylon</i>	Dn [#]
Dendera	<i>Echinaps gignantean</i>	Dn [#]
Metterie	<i>Glinus lattoides</i>	Dn [#]
Gorrtet	<i>Plantago lanceolata</i>	Dn [#]

Dn# = Do not know

Source: Adapted from Berhanu and Ermias (1978), Desta (1995) and Feseha (1995).*

A number of studies conducted in rodents with secondary hydatidosis using benzimidazole derivatives such as albendazole, fenbendazole and flubendazole induced experimentally by intra peritoneal injection of protoscolices of *E. granulosus*. It was found with dose rate equivalent to 30 mg/kg-50 mg/kg body weight daily, for 60-80 days, that severe damage or killing of *E. granulosus* cysts occurred (Smith, 1994). Extensive trials with benzimidazole have also been carried out in rodents infected with metacestodes of *E. multilocularis*. In trials using long- term treatments with albendazole (60 days), fenbendazole (60-200 days), flubendazole (60-200 days) and mebendazole (60-300 days) at 30 mg/kg-50 mg/kg b.w there was up to 99% reduction in metacestode weight as compared with untreated controls (WHO/OIE, 2002).

2.7 Control

The life cycle of *T. saginata* requires contact between man (final host) and cattle. Strict hygiene measures therefore break the life cycle of these parasites (Schantz *et al.*, 1998). The best way to prevent, infection with taeniosis is to eliminate the exposure of livestock to the tapeworm eggs by properly disposing of human feces. The next best strategy is to apply processing (Table, 3). Larval cysts in meat are killed by moderate temperatures of 150°F (65°C) or frozen for at least 12 hours (Gracey *et al.*, 1999).

Onyango-Abuje (1984) review potential ways of controlling *T. saginata* proper disposal of human faeces and preparation of meat before consumption are considered to be important. The construction of latrines and encouraging their use is recommended. The public should be educated about the life cycle of the tapeworm, making use of all available media and taking into account low levels of literacy. Cooperation between medical and veterinary services is considered important (Cheruiyout and Onyango-Abuje, 1984). Meat inspection is also important. The effectiveness of many inspection regimes may be poor. Ogurinde and Oyekele, (1990) report the sensitivity of screening for cysticercosis in an abattoir in Ibadan in Nigeria to be 0%. Walther and Koske (1980) found that inspecting meat by the legally presented method discovered only 38% of infected calves at an abattoir in the Samburu District of Kenya and suggest that the usual rate of detection where less time is spent would be lower. Indeed, 56.7% of infected calves in the study were free of cysts at the so-called sites of predilection. Sites of infection will vary with geographical area, breed of cattle, age and the activity of the muscle. The choice of muscle studies by meat inspectors should be based on studies within the country or region (Pugh and Chambers, 1989). Shortages of trained personnel, lack of sanitary facilities including electricity and running water are suggested as reasons for poor performance (Kambarage, 1995; Maeda *et al.*, 1996; Ogurinde and Oyekele, 1990). Meat which not inspected is often consumed in rural areas at the time of marriages and other festivals (Cheruiyout and Onyango-Abuje, 1984).

Maeda *et al.* (1996) noted that traditional methods of slaughter, dressing and marketing create difficulties for inspection. Time is lost during manual killing and dressing of carcasses and

butchers are impatient to get the meat to the retail markets. Butchers may also oppose inspection due to fears about loss of earnings. The practice of slaughtering animals early in the morning when light is not good, in Tanzania does not favor good inspection (Meada, 1996). Kambarage (1995) report that in Tanzania, inspection is normally carried out in the presence of the owners, which is also likely to influence the judgment of the inspectors. The efficacy of traditional remedies has received some attention. Some success has been achieved using the fruit *Mallotus philippinesis* or 'Kamala' to treat gastrointestinal cestodes in goats (Akhtar and Ahmad, 1992). A practical vaccine to prevent infection with the parasite in cattle would be valuable and would assist in control of transmission of the parasite to humans, the obligate definitive host (Lightowlers *et al.*, 1996).

A small proportion of urban sewage sludge is used for pasture fertilization, and it has been possibly involved in several outbreaks of cattle cysticercosis (Cabaret, 2002). The regulations on the use of sewage sludge are intended to reduce the helminthic risk and for example in France, sanitized sewage sludge (with less than 3 eggs of helminths/10 g dry matter); a delay of 3 weeks is required between the spread of sludge and the grazing of pastures. When unsanitized sludge is used, this delay extends to 6 weeks. Unsanitized liquid sludge is very common in rural areas and spreading on cultivated lands or pasture remains the only means to use this type of sludge. We do not know if regulations are efficient to reduce the risk of cysticercosis in cattle as a small proportion of *T. saginata* eggs survive up to 8.5 months when deposited on pastures (Ilsoe, 1990). Two tests to evaluate cysticercosis are performed as infection is expected to be of low intensity: Sandwich-ELISA (Dorny *et al.*, 2004) and examination of cysticercosis lesions of carcasses. Slurry is spread on land and represents a much larger volume than sludge (20 times more in dry-matter). Cattle slurry is a source of pathogens, among which is digestive-tract strongyles (Juris *et al.*, 1996). The presence of urine in slurry (Helle *et al.*, 1989) and anaerobic conditions (Kates, 1950) in tanks reduce the survival and potential to develop into infective larvae (Persson, 1974). Cysticercosis in cattle is screened in European Union Member states as a consequence of routine meat inspection procedure and the prevalence of bovine cysticercosis and human taeniosis ranges from 0.007 to 6.8 for cysticercosis and 0.02 to 1.64 for the incidence of taeniosis (Table 4).

Table 3: Effect of processing on bovine cysticercosis in meat and meat products

Process	Characteristics	Effective on cyst
Freezing	<-5 ⁰ C for 360 hours	Death of the cyst
	<-10oC for> 216 hours	Death of the cyst
	<-15 ⁰ C for> 144 hours	Death of the cyst
Heating	>56 ⁰ C core temperature for >1 second	Death of the cyst
Irradiation	100K rad.	Death of the cysts
	40K rad.	Inhibition of development
Pickling	a _w <0.86 for 3-4 weeks	Death of cyst shown under experimental condition
Cutting/Mincing		No effect of cyst

Source: E.C. (2000).

2.8 Prevalence and Economic Impact

2.8.1. Prevalence

Taenia saginata is globally distributed (Soulsby, 1982). Taeniosis prevalence could be classified in to three groups (Pawlowski and Schultz, 1972). According to Pawlowski and Schultz (1972), the prevalence and distribution of taeniosis/cysticercosis (*T. saginata*) could roughly be classified in to three groups namely: Low infection rates less than 0.1% moderate infection rate and highly endemic with taeniosis prevalence exceeding. 10%. Central and East African countries like Ethiopia, Kenya and Zaire are those countries that are highly endemic with the prevalence of bovine cysticercosis in a population. Those with moderate infection rates (endemic case) encompass areas like Caucasian and South Central Asian Russian federation Republics of United Soviet Socialist Republic and in the Mediterranean (Syria, Lebanon and Yugoslavia) and countries with a prevalence below 0.9% or even free from taeniosis include Europe, North America, Australian and New Zealand (Urquhart *et al.*, 1996). The prevalence of cysticercosis in cattle and taeniosis in human is summarized in (Table 4).

The situation of this disease in Africa is quite common, reaching 3.2-7.5% in Nigeria (Okolo, 1986; Fertig and Dorn, 1985), 12.5% in Botswana (Mosienyane, 1986) greater than 10% in Sudan (Frolova, 1985), 30-39% in Kenya, 15% Rwanda, 20% in Guinea and 31% in Burundi (Pagot, 1992). *Taenia* infestation was higher in private school pupils than in the public school pupils. This might probably be due to affluence because roasted meat is a delicacy for the children of the rich and these children are the ones in most cases that go to private schools because their parent can afford the high school fees that are paid there (Adebolu and Badamus, 2004).

Associated *Taenia* infections in humans have been reported to be 8.6% in Nigeria and 10% Sudan. It is not always clear from abattoir surveys where the animals in question were raised, but there is some evidence that pastoral areas are particularly badly affected. In East Africa, for example, 75.9% of calves in Samburu district, Kenya, were infected with *T. saginata* (Walther and Koske, 1980). Mango *et al.* (1974) report that 18.2% of cattle surveyed in Kenya were found to be infected with *C. bovis*, with the worst affected areas being Nyanza, Rift Valley and North-Eastern Provinces. A sero-epidemiological survey of cattle in the Rift Valley, Eastern and North Eastern Provinces of Kenya, revealed that Rift Valley province was the most seriously affected by *T. Saginata* (Cheruiyout and Onyango-Abuje, 1984). The high prevalence was caused by the management practices of pastoralists such as in Narock district where a survey was carried out. Cattle graze alongside the stockmen during the day and are brought back to barn in the evening, thereby creating continuous contact between cattle and humans. It is suggested that the increased prevalence during the drought in Botswana in the early 1960s was due to the congregation of cattle at watering places and their proximity to the human population (Grindle, 1978).

Dada (1978) has reported that 1.9% of cattle were infected with *C. bovis* and 1.0% of sheep and 0.8% of goats were infected with *Cysticercus ovis*. In southern Africa, 2.16% of cattle carcasses in Matabeleland province, Zimbabwe, were infected with *C. bovis* (Pugh and Chambers, 1989). Cattle infections by *C. bovis* are widespread. Prevalence figures from Senegal (20%), Nigeria (0.2%), Cameroon (7.2%), Tanzania (0.27%) and Kenya (38%) illustrates this. In a certain region of Kenya a decline from 15 to 8% during the last years, was

described. In Zambia a prevalence of 1.5% of *C. bovis* infections in cattle has been determined. In Botswana the incidence has increased to 13%. Stringent control measures are necessary to save the meat export (Over *et al.*, 1992).

Bovine cysticercosis is found in 9.0% of animals slaughtered in Botswana (OIE, 2001). *Cysticercus bovis* is found in between 1% and 40% of cattle in Kenya, Uganda, Sudan, Tanzania, Nigeria, Botswana, Zimbabwe and south Africa (Giesecke, 1997) and 10% of human in Ethiop, Kenya and Democratic Republic of Congo (formerly Zaire) are reported to have *T. saginata*. Antia and Alonge (1982) report that in South Nigeria, cysticercosis accounted for 63.2% of carcass condemnation in cattle, 29% in goats and 66.7% in swine. Cysticercosis has been reported in pigs in Bhutan and in Malaysia and in cattle in India and Thailand (OIE, 2001). In Uttar Pradesh, India, 4.3% of pigs were found to have cysticercosis and 2.0% of human had *Taenia* (Ruiz, 1997). The disease has also been reported in China, Korea, Indonesia and The Philippines and is possibly present in Thailand. *T. saginata* has been reported in China, India and Cambodia and is highly prevalent in Laso.

It is clear that in many of the areas for which information is available, cysticercosis is a serious problem for livestock producers. There are considerable variations in the prevalence of the disease in different species and in different areas that are not easily explained by existing information. However, it appears that *Taenia* infections and cystic infections are usually associated with poor groups (Ruiz 1997).

The pattern of cysticercosis indicated human faecal contamination of a regionally available feed source. Of feedstuffs in use, potato waste a byproduct of the processed potato industry, appeared to be the most likely source of *T. saginata* ova (Hancock *et al.*, 1989). The incidence of *C. bovis* in carcasses of cattle originating from communal areas was 3.2 per cent compared with 1.6% in those originating from commercial farms (Pugh and Chambers, 1989).

Among human or animal wastes, sewage sludge, manure and slurry used in agriculture are a real health concern. Sewage sludge has been for years as a land fertilizer in many countries. It

is a possible source of pathogens, of which *Taenia* species is an important component. In Western Europe and USA, *T. saginata* is nearly the unique *Taenia* species found.

Table 4: The prevalence of bovine cysticercosis and incidence of human taeniosis in various European countries

Country	Cysticercosis*(%)	Taeniosis** (%)	Reference
Denmark	0.1-0.7	0.02	Ilose <i>et al.</i> (1990)
Germany:			
former East	4.5-6.8	0.33-0.62	Mobius (1993)
former West	0.4-0.8	0.09	Zimmerman (1953)
Netherlands	1.8-2.2	0.14	Van Knapen and Buys (1985)
Belgium	0.03-0.2	0.26-0.46	Geerts <i>et al.</i> , (1992)
Spain	0.007-0.1	-	Garate, 1999
Poland	0.24	1.64	Pawlowski, 1999
Italy	0.02-2.4	0.02-0.04	Battelli, 1999

*prevalence based on the abattoir data

** Incidence based on sales of specific antiparasitics drugs in man.

Source: E.C. (2000).

In Ethiopia, bovine cysticercosis and human taeniosis are endemic. Several studies have documented their presence in a wide area of the country. Table 5 summarizes the prevalence of cattle cysticercosis and human taeniosis.

Table 5: The prevalence of bovine cysticercosis and human taeniosis in Ethiopia

Study area	Method of Examination	Prevalence (%)		Author
		Cysticercosis	Taeniosis	
Akaki	Stool	-	2.9%	Mamo <i>et al.</i> , 1989
Wondo Genet	Stool	-	4.0%	Erko and Medhin, 2003
Awassa	Postmortem	26.25	-	Abunna <i>et al.</i> , 2008
Wolaita Soddo	Questionnaire	-	50.63	Regassa <i>et al.</i> , 2009
Delgi	Stool	-	5.3%	Ayalew <i>et al.</i> , 2011
Zeway	Postmortem	3.0%	-	Bedu <i>et al.</i> , 2011
Kombolcha	Postmortem	26.7%	-	Endris and Negussie, 2011
Addis Ababa	Postmortem	3.6%	-	Ibrahim and Zerihun, 2012
Wolaita Soddo	Postmortem	2.59%	-	Tesfaye <i>et al.</i> , 2012
Hintallo-Wejerat	Stool	-	0.62%	Tadesse and Tsehaye, 2008

Due to lack of representation in all data from many countries, it can only provide an incomplete and preliminary picture of the present geographic distribution of echinococcosis and hence the epidemiological public health problem is numerous. From several regions, there are alarming indications of increasing human health risks caused by echinococcosis. These facts should be reasons for health authorities to establish internationally coordinated systems of surveillance and risks assessment and to improve and support measures for the control and presentation (Smith, 1994).

Echinococcus granulosus has a worldwide geographic distribution and occurs in all continents. High parasite prevalence is found in parts of Mediterranean region, Russian Federation and adjacent independent states, the Peoples Republic of China, Africa (Northern and Eastern region), Australia and South America (Rausch, 1995; Andersen *et al.*, 1998; Dalimi *et al.*, 2002; Jenkins *et al.*, 2005). Table 6 presents the prevalence of animal hydatidosis/echinococcosis in some Sub-Saharan countries.

Table 6: The prevalence hydatidosis/ echinococcosis in Subsaharn countieres

Country	Period	Number of Animal Infected/Examined					Percentage
		Hydatidosis			Echinococcosis		
		Cattle	Sheep	Camel	Pig	Dog	
Nigeria	1988	-	-	-	12/360	-	3.3
	1990-1993	-	-	501/24,531	-	-	2.0
Sudan	1992-1996	-	-	159/400	-	-	4.3-8.2/year
Ethiopia	1996	-/2717	-	-	-	-	24-46
	1996	-	-	-	-	-/110	14.5
	1996	-	-/630	-	-	-	2-26
Zambia	1984-85	69/482	-	-	-	-	14.3

Source: WHO/OIE (2002)

It is difficult to present exact data of human infection from recent years on the rates of morbidity, mortality and fatality. In the regional hospital of Maldivian Chle, 137 new cases of cystic echinococcosis was registered in 1987-1991; the mortality rate was 0.2%/per 100,000 populations and the fatality rate 2.25. In some European countries or egioms, the annual incidence rates of hospital cases of human cystic echinococcosis (CE) vary between 1.0 and 8.0 per 100,000 populations in 1990, but up to 42 per 100,000 in one of the countries (WHO/OIE, 2002). High incidence rates or prevalences have also been recorded from countries in Northern Eastern Africa (prevalence up to >3%) and South America (Uruguay annual incidence of 6.5% per 100,000 population in 1997). The occurrence of *E. granulosus* is sporadic or ha not been reported from other regions, including countries in Northern and Central Europe, in the Pacific Region, and in the Caribbean (Urquhart *et al.*, 1996). The highest numbers of cystic echinococcosis cases were recorded in older age groups, for instance between 21 and 30 years (Kenya) or 21 to 40 years (Libya). In Ethiopia, the occurrence of the disease in man has been reported by Hagos *et al.* (2006), 137 patients seen with hepatic hydatidosis and (Mesfin *et al.*, 2007) 234 patients operated upon for hydatid disease between September 1995 and August 2005 were analysed. But information is lacking in most hospitals

and health centers due to the absence of diagnostic facilities, asymptomatic and chronic nature of the disease as well as failure to document. The occupational distribution of patients may vary widely from country to country depending on epidemiological and socio-economic circumstances.

Echinococcus multilocularis is distributed in the northern hemisphere, including endemic regions in central Europe, most of northern and central Asia, parts of North America and possibly isolated focus in northern Africa (Tunisia). *Echinococcus multilocularis* in red foxes varies from <1% to >0.6% (WHO/OIE, 2002).

Human cases of alveolar echinococcosis (AE) were recorded in recent years from seven central European countries (0.02%-1.4% cases per 100,000 populations). Up to May 1999, more than 400 live Alveolar echinococcosis patients from six countries were registered in an ongoing pilot study, most of them from France, Switzerland and Australia. In the Mediterranean region, human cases of alveolar echinococcosis are recorded from Turkey and Iran (Raush 1995; Anderson *et al.*, 1998; Eckert and Desplazes, 2004). *Echinococcus multilocularis* is endemic in large of the Russian Federation and adjacent countries (Belarus, the Ukraine, Moldova, Georgia etc.). It is mainly distributed in the western and central parts.

Echinococcus vogeli and *E. oligarthus*, the causative agents of human polycystic echinococcosis (PE) are endemic in central and South American countries. To date at least 96 human cases of polycystic echinococcosis have been diagnosed in an area stretching from Nicaragua in the north to Chile, Argentina and Uruguay in the south, but it is assumed that the real extent of the disease is not yet fully assessed (Khuroo, 2002).

Hydatidosis or echinococcosis in animals is endemic in Ethiopia. In cattle, a prevalence of hydatidosis ranging from 19.7% to 49.8% and in dogs a proportion of echinococcosis varying from 0-33.3% has been reported (Table 7).

Table 7: Summary of works so far conducted on animal hydatidosis/echinococcosis in Ethiopia

Study Area	Prevalence (%)					Author
	Hydatidosis			Echinococcosis		
	Cattle	Sheep	Goats	Camels	Dogs	
Gondar	33.78	8.07	4.64	-	-	Tamene Melaku (1980)
Welaita	33.35	-	-	-	31.5	Abel Mersie (1985)
Debre Zeit	46.5	12.46	1.7	-	0	Yilma Jobre (1985)
Gondar	224.3	-	-	-	24	Roman Tiruneh (1987)
Gamugofa Province	25.88	-	-	-	33.3	Mohammed Abdela (1988)
Arsi Province	54.8	2.18	0	-	-	Alemayehu Lemma (1990)
Awassa	34.3	-	-	-	0	Getachew Jember (1991)
Debre Markos	48.9	-	-	-	-	Kebede <i>et al.</i> (2009a)
Adama	46.8	29.3	6.7	-	-	Getaw <i>et al.</i> (2010)
Ambo	29.69	-	-	-	25	Zewdu <i>et al.</i> (2010)
Addis Ababa				21.2		Jenberie <i>et al.</i> (2011)
Borena, Kereyu and Harar				22.6		Salih <i>et al.</i> (2011)
Addis Ababa	19.7	13.47	-	-	-	Fikire <i>et al.</i> (2012)

2.8.2 Economic impact

Economic losses from cysticercosis are determined by disease prevalence, grade of animals' infested, potential market price of cattle and treatment cost for detained carcasses. For example in Botswana and Kenya, the incidence of cysticercosis at export abattoirs is about 8 and 12% respectively. Annual losses in Botswana now approach 0.5 million pounds, while in Kenya it is about 1 million pounds. The loss per animal slaughtered is 2.25 pounds in Botswana and 1-50 pound while in Kenya. The important reason for condemned meat at abattoirs in Central Africa Republic and Burundi is due to cysticercosis (Pagot, 1992). Apart from direct losses, there are other important consequences of cysticercosis. This is especially true in East Africa where the development of profitable meat industry is hampered by high prevalence of *C. bovis*. In feedlots situation, cysticercosis can cause a crippling economic blow and may prevent the survival of the enterprise, particularly where it is not able to insure against such losses one such loss was estimated at 2,567,799 dollars in Yugoslavia (Blazek and Schramlova, 1983). In general, *C. bovis* has an impact in meat trade is increasingly becoming important in view of the drastic measures and very strict regulations importing countries such as the European Economic community and the gulf states (Feseha, 1995). The economic significance of the adult parasite (*T. saginata*) and the proportion of carriers requiring hospital treatment was over 20% in Poland and 10% in France. It is also assumed that each carrier misses one day work on average in France (WHO, 1983).

Based on the data collected by Bartake *et al.* (1982) from fattening houses, economic consequences of cysticercosis in cattle reared on the farm Ceske Velenice (district of Jindrichuv Haradec) were evaluated. The highest percentage of bulls suffering from cysticercosis at the time of purchase was found in 1976-69.1% beginning the April of 1976, the occurrence amounted almost to 100%; the decrease started in the April of 1977. Cysticercosis affected the average realization price, which in 1976 was as low as 8056 Kcs (Czechoslovak crowns) per one kg of live weight. In that year, financial losses amounted up to 6.93 Kcs 1 kg of live weight in all sold animals. The total direct financial losses due to cysticercosis in the bulls on this farm equaled 2,567,799 kcs, till the year 1978 when this parasitosis was eradicated (Bartake *et al.*, 1982). The significance of cysticercosis was summarized in Appendix 2.

The economic inference of bovine cysticercosis in the livestock production system is multidirectional and has a serious impact on the economy of meat industry (**Table, 8**).

Table 8: Economic implication of cysticercosis in cattle

Morbidity	Diminution of natural resistance of the host's organ	Additional expenses for treatment of animals
Fodder consumption		Reduction of meat production and milk yield
Retardation of growth and development		Losses due to mortality and forced slaughter
Condemnation of meat and organs from infected animals		Restriction of import export relations
	Diminution of reproduction capacity	

Source: Olteanu, G, (1982)

The economic impact of the disease in the cost implication can be broken down in to those involved in treating human taeniosis and cattle carcasses (cost of freeing, boiling) or condemned, as well as the costs involved in the inspection procedures amount to millions of dollars (Nummes, 1984). Conventional meat inspection technique is less sensitive (pick only 7-5% of infected cases) and time consuming. Lightly infected carcasses can be easily missed and passed for human consumption, thus the infection transmission is maintained between human and cattle. Thus taeniosis (cysticercosis) is remaining a wide spread zoonosis that affects human health and economy through condemnation, quality degradation of frozen meat, cost of refrigeration, cost of human therapy, lowering productivity of infected workers who may be absent from or reduce their working efficiency by creating uneasiness (Nigatu, 2004). In Ethiopia, there is a wide usage of both traditional and modern taenicidal drugs (Feseha, 1995), which is an indication and diclorophen production in the drug factories in this country (Table 9) between 1996 and 2000 was 31,814,833. The annual expenditure for the modern drugs in three

areas of Shoa (Akaki, Debre zeit and Nazareth) was estimated at 1,471,281 Eth. Birr (Table 10) during the year 2000 (Tembo, 2001).

Table 9: Taenicidal drugs production at the Ethiopia pharmaceutical company for a 5-year period

Year	Annual dose		
	Niclosmide	Diclorophen	Total
1996	2,548,500	2,225,667	4,774,167
1997	4,484,000	538,500	50,022,500
1998	9,418,125	2,665,333	12,083,458
1999	4,484,000	416,8000	4,900,833
2000	5,033,875	-	5,033,875
Total	25,968,500	5,846,333	31,814,833

Source: Tembo (2001)

Table 10: Inventory of annual taenicidal drugs dose and their worth in central Ethiopia.

Taenicidal Drugs	Akaki		Debre Zeit		Nazareth		Total	
	Doses	Worth (Birr)	Doses	Worth (Birr)	Doses	Worth (Birr)	Doses	Worth (Birr)
Albendazole	553	11,446	8,825	105,691	24,526	486,039	33,904	603,176
Diclorophene	12,520	19,406	3,443	5352	2,738	4,107	18701	28,865
Mebendazole	14,711	54,587	36,442	99223	71,187	481,992	122320	635,802
Niclosamide	33,219	30,783	37,720	35446	106,882	113,211	177821	179,460
Praziquantel	553	1,490	4,278	9,592	4,078	13,436	8909	24,518
Total	61,556	117,712	90,688	255,324	209,411	1,098,783	361,655	147,1821

Source: Tembo (2001)

The main hydatid-induced losses in ruminants are productivity losses (reduction in carcass weight, milk production, and fleece value), losses of offal (liver, lung, kidney, and heart), and fertility losses (Sariozkan and Yalcin 2009; Yildiz and Gurcan 2003).

According to recent of WHO/OIE (2002) the various consequences of human cysts echinococcosis include:

- Cost for diagnosis of the infection
- Medical and surgical, feeds and costs of hospitalization, nursing and drugs.
- Loss of working days or “production”
- Cost of travel to seek treatment for both patient and family members.
- Mortality (potential years of life lost)
- Suffering and social consequences of disability.
- Abandonment of farming or agricultural activities by affected or at risk persons.

According to recent report of WHO/OIE (2000), the various consequences of hydatid cysts or cystic echinococcosis including:-

- Cost fo diagnosis of the infection
- Medical and eurgical feeds and costs of hospitalization nuosing and drugs.
- Loss of weaking days of production
- Cost of truuel to scek treatment for both patients and family members.
- Mutually (pakenfcsl yrs of life lost)
- Suffering and social consequences of disability.
- Abandonment of farming or grateful acfillitis by affected or at risk perseus.

According to Smith (1994) the fallowing consequences cystic echinococcosis have in livestock to the followed

- Reduced yield and quality of meat lick and wool reduced birth rate etc.
- Delayed performance and growth

- Condemnation of organs especially is care and dead animals.

Considering the economic significance due to bovine hydatidosis in Ethiopia, significant degrees of monetary losses were estimated at various levels in different locations. Such reported estimates indicate annual losses 1,791,625.89 Ethiopian birr (ETB) and (131,737.19 USD) in cattle slaughtered at the Hawassa municipal abattoir (Regassa *et al.* 2010), 410,755.90 ETB (30,202.64 USD) in cattle slaughtered at Wolayita Sodo abattoirs (Bekele and Butako, 2011) and 45,532.9 ETB (5059.2 USD) in cattle slaughtered at the Adama abattoir (Getaw *et al.* 2010).

3. MATERIALS AND METHODS

3.1 Study Area

The study was conducted at Addis Ababa abattoirs enterprise for six months between November 2012 and April 2013. Addis Ababa is the capital city and administration center for the Federal Democratic Republic of Ethiopia. Currently there are 10 Subcities or “Kifle Ketemas” in Addis Ababa city administration delineated on the basis of geographical set up .population density asset and service provides ‘ distribution and convenience for administration (AACAA, 2004) Addis Ababa is situated at latitude of 9°3’ North and 38°43’ East (ILCA ,1994). It lies in the central highlands of Ethiopia at an altitude of 2500 m.a.s.l. It has an average rainfall of 1800 mm per annum. The annual average maximum and minimum temperature is 26°C and 11°C, respectively; with an overall average of 18.7°C. Highest temperatures are reached in May. The main rainy season extends from June to September. Addis Ababa has a relative humidity varying 70% to 80% during the rainy season and 40% to 50% during the dry season .The human population is estimated at about 3 million inhabitants (NMSA. 1999)

Addis Ababa slaughterhouse serves people residing in and the surrounding of Addis Ababa. At Addis Ababa abattoir cattle, sheep, goats and swine are slaughtered. Animas for slaughter are derived from different regions of the country. Daily slaughtered animas are 700 cattle, 250 sheep, and 75 goats. About 50 swine’s are slaughtered per week .On average 153,000 cattle, 39,000 sheep 3,200 goats and 750 swine are slaughtered annually. The study will be conducted on meat Carcass derived from apparently healthy slaughtered cattle originating from the different corners of the country.

3.2 Study Subjects

The study animal population consisted of all cattle brought from Arsi, Borana and Wolaita and slaughtered at Addis Ababa abattoirs enterprise and presented routine meat inspection. The

study sample comprised of only male cattle of different breeds, age groups and body conditions. The animals were transported to the abattoir mainly using vehicles.

Human study subjects used for this study were recruited from elementary school and government offices and house to house visits. Human study subjects that were interviewed comprised of the two sexes, different age groups, educational backgrounds, marital status and various types of meat eating habits.

3.3 Study Design and Sampling Strategy

A cross-sectional study design was involved during the surveillance of bovine cysticercosis and hydatidosis conducted from November 2012 to April 2013 at Addis Ababa abattoirs enterprise. Abattoir visits were made only two days per week, the days were selected by their greater number of slaughter. The sample units were selected using systematic random sampling method from those cattle originated from Arsi, Borana and Wolaita and slaughtered at Addis Ababa abattoirs enterprise on Wednesday and Friday only.

Likewise, for the questionnaire survey a cross-sectional study was made in which case school children, civil servants, house wives and private workers were selected randomly and interviewed by the researcher following a verbal consent.

3.4 Sample Size Determination

The sample size was required for this cross-sectional study on bovine cysticercosis and hydatidosis was determined using the formula recommended by Thrusfield (2005) for random sampling.

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

Where,

n = required sample size

P_{exp} = expected prevalence

d = desired absolute precision

With an expected prevalence 50% as there are no previous studies on metacestodes of cattle as a whole in the abattoir, 95% confidence level and 5% accepted error, the estimated sample size was 384 animals. However, in this study a total of 410 cattle were sampled and inspected during the study period for presence the metacestodes (*Cysticercus bovis* cyst and hydatid cyst).

Similarly, for the questionnaire survey the required sample size was calculated using the single proportion population formula. The sample size at prevalence of 3.2% in Akaki (Mamo *et al.*, 1989), 95% confidence interval and a 5% margin of error was 48. However, to increase the precision of our various estimates this was doubled and a 10% contingency was added to make it 110.

3.5 Study Method

3.5.1 Abattoir survey

The study animals were selected during antemortem inspection and animal data such as origin, breed sex and age of the animals were recorded on specially designed sheet (Appendix 3; Tables in the Appendix 1 and 2) before slaughtering. The method of age and body condition determination are presented in (Appendix 4 and 5). Following their slaughter, detailed meat inspection has been conducted on the 410 selected cattle. Whenever *C. bovis* and/or hydatid cysts were encountered, the samples were transported to Addis Ababa University, College of Veterinary Medicine and Agriculture Parasitology Laboratory for size measurement and conformation of fertility and viability.

3.5.2 Laboratory examination

Those cysts suspected of being *C. bovis* were incubated at 37°C for 1-2 hours using 40% ox bile solution diluted in normal saline. Then, the scolex was examined under microscope by pressing between two glass slides. The cysts were regarded as viable if the scolex evaginates during the

incubation period. Additionally, the scolex was checked whether it is *T. saginata* metacestode or other species based on the size of *Cysticercus* and absence of hook on the rostellum of the evaginated cyst (OIE, 2004; Anoskie, 2011).

For hydatid cyst, individual cysts were grossly examined for any evidence of degeneration and calcification, and then checked by transferring in to a sterile container and examined microscopically (40×) for the presence of protoscoleces. Protoscoleces viability was assessed by the motility of flame cells as well as staining with 0.1% aqueous solution of eosin (OIE, 2004). They were called fertile if containing protoscolices and germinal membrane; sterile when there were no protoscolices; viable when protoscoleces didn't take up the stain; nonviable when it took the stain.

3.5.3 Questionnaire survey

The interview was conducted by the authors using a structured questionnaire (Appendix 1). The potential risk factors of taeniosis, such as age (12-65 years), sex, religion, occupation, educational levels, habit of raw meat consumption and marital status, were considered. Occupationally high-risk groups such as abattoir workers, butcher men, meat inspectors, cooks and farmers whose work expose them to cattle meat and meat products. Whereas, the low-risk groups were arbitrarily selected as those who do not have as such a strong relationship with meat and meat products, such as other civil servants and private workers.

3.5.4 Ethical Clearance

Before administering the questionnaire to the respondents, the objective of the study was explained to the study participants to get informed verbal consent.

3.5.5 Taenicial drug inventory

For the purpose of determining the amount of taenicial drugs sold and the amount they worth, five volunteer private and government drug shops and the Ethiopian Red Cross Society pharmacy were inventoried for the period of 2009 to 2012.

3.6 Data Analysis

The data gathered during the study were entered into a Microsoft excel spreadsheet. Then after, the data were edited, coded and analysed using Stata analyzed using STATA 11 intercooled statistical software (StataCorp, 2009). The overall prevalence of metacestodes infection, cysticercosis and hydatidosis was calculated as the number of cattle found harbouring metacestodes, *C. bovis* and hydatid cyst divided by the number of animals examined expressed as a percentage of the total number of cattle slaughtered. The infection rate was calculated on the basis of origin, breed and age groups animals and analyzed to see association with the different variables. A univariate logistic regression analysis was made to show the effect of origin of animal on the proportion of infection. A significant effect said to exist if the 95% confidence interval (CI) Odds Ratio doesn't include one.

4. RESULTS

4.1 Abattoir Survey

4.1.1 Overall prevalence

From a total of 410 cattle carcasses examined at the time of slaughtering, 160 were found infected with metacestodes of *T. sagnata* and *E. granulosus*. The overall prevalence of metacestodes infection in cattle was determined to be 39.02% (95% CI = 34.27-43.93). Among cattle carcasses harbouring metacestodes, 110 and 70 contained *C. bovis* and hydatid cysts respectively. Therefore, the prevalence of bovine cysticercosis was determined to be 26.83% (95% CI = 22.60-31.40) and that of hydatidosis as 17.07% (95% CI = 13.56-21.07).

4.1.2 Effect of host and environmental factors

The association between origin, breed, age and body condition of slaughtered cattle with that of the prevalence of cysticercosis was assessed using Pearson's Chi-square test statistic. All of the considered environmental and animal characteristics were significantly associated with the prevalence of bovine cysticercosis ($P < 0.05$). The prevalence of cysticercosis was higher animals obtained from Arsi (35.96%) than that of Borana (13.27%) and Woliata (17.86%). With regard to breed, cross breed animals showed higher predisposition to *C. bovis* infection (46.15%) than endogenous local breed animals (25.52%). In contrast, adult animals (21.99%) and those with good body condition (24.05%) showed lower infection rates than young animals (37.50%) and those with medium body condition (52.50%) (Table 11).

The univariate analysis has also showed that animals brought from Borana and Wolaita were 0.27 \times and 0.39 \times less likely affected with *C. bovis* than those from Arsi. Similarly, adults showed 0.47 \times less infection than young animals. Unlikely, Cross breed animals and animals with medium body condition exhibited 2.5 \times and 3.49 times more infection than local indigenous breed animals and those with good body condition, respectively (Table 12).

Table 11: Association between proportions and bovine carcasses from different origins, breeds, age and body condition with *C. bovis* infection

Variables	No. of Carcasses		Percentage	χ^2 -Value	P-Value
	Inspected	Infected			
Origin					
Arsi	228	82	35.96	22.321	0.000*
Borana	98	13	13.27		
Woliata	84	15	17.86		
Breed					
Local breed	384	98	25.52		
Cross breed	26	12	46.15	5.2808	0.022*
Age					
Young (< 5 Years)	128	48	37.50	10.7941	0.001*
Adult (\geq 5 Years)	282	62	21.99		
Body Condition					
Good	370	89	24.05		
Medium	40	21	52.50	14.8790	0.000*

*Significant

Table 12: The Logistic regression analysis of the risk factors for bovine cysticercosis.

Variables	No. of Carcasses		OR (95% CI)	P-Value
	Inspected	Infected (%)		
Origin				
Arsi	228	82 (35.96)	1 ^a	
Borana	98	13 (13.27)	0.27 (0.14-0.52)	0.000*
Wolaita	84	15 (17.86)	0.39 (0.20-0.72)	0.003*
Breed				
Local	384	98 (25.52)	1 ^a	
Cross	26	12 (46.15)	2.5 (1.12-5.59)	0.025*
Age				
Young (< 5 Years)	128	48 (37.50)	1 ^a	
Adult (≥ 5 Years)	282	62 (21.99)	0.47 (0.30-0.74)	0.001*
Body Condition				
Good	370	89 (24.05)	1 ^a	
Medium	40	21 (52.50)	3.49 (1.79-6.78)	0.000*

^aReference, *Significant

An assessment on the association between origin, breed, age and body condition and hydatidosis was conducted using Pearson's Chi-square statistical test. Among the considered factors Origin and age of animals were significantly associated with prevalence of bovine hydatidosis ($P < 0.05$). Cattle obtained from Arsi area were found highly infected with hydatid cyst (22.37%) than animals brought from Borana (8.16%) and Wolaita (13.10%). In Addition, adult cattle (19.86%) were more infected than young cattle (10.94%). In contrast, breed and body condition of cattle were not significantly associated with the proportion of infection of hydatidosis ($P > 0.05$). However, local breed cattle were slightly highly infected (17.455) than cross breed animals and cattle with good body condition were slightly lightly infected (16.49%) than those with medium body condition (22.50%) (Table 13).

A univariate analysis has revealed that cattle from Borana were 0.31× less infected than those from Arsi. Besides, Adult cattle (≥ 5 years) were found 2.02 times more frequently affected than young animals (< 5 years) (Table 14).

Table 13: Proportion of bovine carcasses from different origins and breeds infected with hydatid cyst

Variables	No. of Carcasses		χ^2 -Value	P-Value
	Inspected	Infected (%)		
Origin				
Arsi	228	51 (22.37)	10.95	0.004*
Borana	98	8 (8.16)		
Woliata	84	11 (13.10)		
Breed				
Local	384	67 (17.45)	0.60	0.438
Cross	26	3 (11.54)		
Age				
Young (< 5 Years)	128	14 (10.94)	4.95	0.026*
Adult (≥ 5 Years)	282	56 (19.86)		
Body Condition				
Good	370	61 (16.49)	0.92	0.337
Medium	40	9 (22.50)		

*Significant

Table 14: The logistic regression analysis of the risk factors for bovine hydatidosis

Variables	No. of carcasses		OR (95% CI)	P-Value
	Inspected	Infected (%)		
Origin				
Arsi	228	51 (22.37)	1 ^a	
Borana	98	8 (8.16)	0.31 (0.14-0.68)	0.003*
Wolaita	84	11 (13.10)	0.52 (0.26-1.06)	0.072
Breed				
Local	384	67 (17.45)	1 ^a	
Cross	26	3 (11.54)	0.62 (0.18- 2.11)	0.442
Age				
Young (<5 Years)	128	14 (10.94)	1 ^a	
Adult(≥5 Years)	282	56 (19.86)	2.02 (1.08-3.78)	0.028*
Body Condition				
Good	370	61 (16.49)	1 ^a	
Medium	40	9 (22.50)	1.47 (0.67-3.24)	0.339

^aReference, *Significant

4.2 Characterization of Cysts

4.2.1 Cyst location

Cysticercus bovis was found on heart, tongue, liver, diaphragm, shoulder and masseter muscles. Among 151 organs and tissues that were infected with *C. bovis*, the heart, shoulder and masseter muscles were the most frequently affected ones with a relative infection frequency of 31.79%, 25.17% and 23.84% respectively (Table 15). Similarly, 11.71%, 9.27% and 8.78% of the examined animals harboured *C. bovis* in their heart, shoulder and master muscles respectively.

Table 15: Proportion of carcasses infected with *Cysticercus bovis*

Organ or tissue	Number Infected (%) (n=151)	Percentage of Infected Animals (n=410)
Heart	48 (31.79)	11.71
Masseter	36 (23.84)	8.78
Shoulder	38 (25.17)	9.27
Tongue	18 (11.92)	4.39
Diaphragm	6 (3.97)	1.46
Liver	5 (3.31)	1.22
Total	151 (100)	26.83

Table 16 presents the distribution of hydatid cyst in the organs of infected animals. Hydatid cysts were recovered from the lung, liver, kidney, spleen and heart. Lung and liver were found more frequently affected than the remainder with a respective proportion of 56.25% and 23.44% of infected organs respectively. Likewise, majority of the infected animals were found infected with hydatid cyst in their lung (17.56%) and liver (7.32%).

Table 16: Proportion of carcasses infected with hydatid cyst

Organ	Number Infected (%)	Percentage of Animals Infected (n=410)
Lung	72 (56.25)	17.56
Liver	30 (23.44)	7.32
Kidneys	14 (10.94)	3.14
Spleen	5 (3.90)	1.22
Heart	7 (5.47)	1.71
Total	128 (100)	

4.2.2 Cyst count

From a total of 400 *Cysticercus bovis* cysts that were collected from different organs harbouring them, 39% and 31.5% were obtained from the heart and masseter muscle. The mean count of *C. bovis* was higher in the heart, liver and masseter muscle bearing 3.25, 3.2 and 3.5 cysts per infected organ or tissue (Table 17).

Table 17: The count of *C. bovis* by organ infected

Organ	Total cyst collected (%)	Mean
Heart	156 (39)	3.25
Masseter	126 (31.5)	3.5
Shoulder	44 (11)	1.16
Tongue	46 (11.5)	2.56
Diaphragm	12 (3)	2
Liver	16 (4)	3.2
Total	400 (100)	2.65

Concerning hydatid cyst occurrence, the lung and liver were the two organs that were found most frequently infected with the cyst. Seventy-three point four percent of the cysts were collected from the lung whereas 20.4% were from the liver and the remainder from kidney heart and spleen. The average count of hydatid cyst recorded was higher in the lung (5.13) followed by liver (3.37), kidney (1.3), heart (1.0) and spleen (1.0) (Table 18).

Table 18: The mean and range of hydatid cyst count by organ infected

Organ	Total (%)	Mean	Range
Lung	367 (73.4)	5.13	1-45
Liver	102 (20.4)	3.37	1-15
Kidney	19 (3.8)	1.3	1-3
Heart	5 (1)	1.0	1
Spleen	7 (1.4)	1.0	1
	500 (100)	4.27	1-45

4.2.3 Cyst size

Data on the size of hydatid cysts are shown in Table 19. From 388 non calcified hydatid cysts, 186 (47.94%) were small, 162 (41.75%) medium and 40 (10.31%) large. Many of the cysts collected from the lungs were small (43.87%) and medium (46.13%) sized cysts while majority of the cysts obtained from liver (61.54%) were small.

Table 19: The size of hydatid cysts recorded.

Organ	Small (%)	Medium (%)	Large (%)	Total
Lung	136 (43.87)	143 (46.13)	31 (10)	310
Liver	40 (61.54)	17 (26.15)	8 (12.31)	65
Kidney	4 (66.66)	1 (16.67)	1 (16.67)	6
Heart	3 (100)	0	0	3
Spleen	3 (75)	1 (25)	0	4
	186 (47.94)	162 (41.75)	40 (10.31)	388 (100)

4.2.4 Fertility and viability tests

Of the 400 *C bovis* collected and examined for viability 191 (47.75%) were alive while 209 (52.25%) were dead (Table 20). Among the viable cysts 17% and 14.75% were obtained from the heart and masseter muscles respectively. Similarly, majority of the non-viable cysts were encountered in the heart and masseter muscles consisting 22.25% and 16.5% of the dead cysts in that order.

Table 20: The proportion of viable and non-viable *Cysticercus bovis*.

Organs	Total Cyst Collected	Viable (%) (n=400)	Non-viable (%) (n=400)
Heart	156	68 (17)	89(22.25)
Masseter	126	59 (14.75)	66(16.5)
Shoulder	44	36 (9)	8(2)
Tongue	46	23 (5.75)	23(5.75)
Diaphragm	12	2 (0.5)	10 (2.5)
Liver	16	3 (0.75)	13(3.25)
Total	400	191 (47.75)	209 (52.25)

In the case of hydatid cysts, out of 500 cysts collected and examined for the status of fertility, sterility, or calcification, 112 (22.4%) were calcified, 219 (43.8%) sterile, and 169 (33.8%) fertile (Table 21). And out of 169 fertile cysts 58 (34.3%) were live whereas 111 (65.7%) dead. The majority of viable and cysts were obtained from the lung that were 29.6% and 55% respectively.

Table 21: The proportion of fertile and viable hydatid cysts.

Organs	Total (%)	Calcified (n=500)	Sterile (n=500)	Fertile (n=500)	Viable (n=169)	Non-Viable (n=169)
Lung	367 (73.0)	57 (11.4)	167 (33.4)	143 (28.6)	50 (29.6)	93 (55.0)
Liver	102 (20.0)	37 (7.4)	43 (8.6)	22 (4.4)	7 (4.1)	15 (8.9)
Kidney	19 (4.0)	13 (2.6)	5 (1.0)	1 (0.2)	0	1 (0.6)
Heart	5 (1.0)	2 (0.4)	2 (0.4)	1 (0.2)	0	1 (0.6)
Spleen	7 (1.0)	3(0.6)	2 (0.4)	2 (0.4)	1 (0.6)	1 (0.6)
Total	500 (100.0)	112 (22.4)	219 (43.8)	169 (33.8)	58 (34.3)	111 (65.7)

4.3 Questionnaire Survey

During the questionnaire survey, the respondents have told their infection with *T. saginata* either by finding proglottids in their faeces, or by stool examination at health institutions. The data has been presented in Table 22. From a total of 110 interviewed persons, 70 (63.64%; 95% CI: 53.92%-72.60%) disclosed they have contracted infection. Up on univariable logistic regression analysis of various characteristics, the proportion of infection with *T. Saginata* varied significantly between the two sexes, among the different age groups, religion, occupation, meat eating habits and uses of spices ($P < 0.05$). Concerning gender, females were found less affected as compared to males (OR = 0.24; 95 CI = 0.11-0.55; $P = 0.000$). Among the different age groups considered, those between 15 and 26 years were 10.83 \times (95%CI = 2.05-57.27) more infected than those below 15 years. Likewise, those 27-40 years and above 40 years were 14.17 \times (95% CI = 2.71-74.11) and 6.67 \times (95% CI = 1.05-42.43) more infected than those under 15 years of age. From the two religious groups, Christians' were more prone to beef tapeworm infection than Muslims (OR = 4.57; 95 CI = 1.56-13.41; $P = 0.006$). High risk groups that have frequent exposure too cattle meat and their products showed 8.17 (95% CI = 3.25 – 20.54; $P = 0.000$) times, raw meat eaters 14.29 (95% CI = 5.92 – 34.42; $P = 0.000$) times times and spice users 2.59 (95% CI = 1.17 – 5.76; $P = 0.019$) times higher infection than the low risk groups, cooked meat eaters and those who do not use spice.

Table 22: The risk factors of *Taenia saginata* taeniosis in human respondents.

Variables	No. of Respondents	No. Infected (%)	OR (95% CI)	P-Value
Sex				
Male	65	50 (76.92)	1 ^a	
Female	45	20 (44.44)	0.24 (0.11-0.55)	0.000*
Age				
<15 years	12	2 (16.67)	1 ^a	
15-26 years	38	26 (68.42)	10.83 (2.05-57.27)	0.005*
27-40 years	46	34 (73.91)	14.17 (2.71-74.11)	0.002*
>40 years	14	8 (57.14)	6.67 (1.05-42.43)	0.045*
Religion				
Muslim	18	6 (33.33)	1 ^a	
Christian	92	64 (70.33)	4.74 (1.61-13.94)	0.005*
Marital Status				
Single	38	24 (63.15)	1 ^a	
Married	72	46 (63.89)	1.03 (0.46-2.33)	0.940
Occupation				
Low risk	55	23 (41.82)	1 ^a	
High risk	65	47 (85.45)	8.17 (3.25-20.54)	0.000*
Educated				
Informal	25	17(68.00)		
formal	85	53 (62.35)	1.22 (0.49-3.05)	0.667
Meat eating habit				
Cooked meat	51	21 (41.18)	1 ^a	
Raw meat	59	49 (83.05)	14.29 (5.92-34.42)	0.000*
Spices				
No spices	47	24 (51.06)	1 ^a	
Use spices	63	46 (73.02)	2.59 (1.17-5.76)	0.019*
Total	110	70 (63.64)		

4.4 Drug Inventory

Drug inventories of five from ten requested drug shops and pharmacies revealed that human *Taenia saginata* taeniosis is an important disease among the residents of Addis Ababa city. The type, dose and worth of taenicial drugs that are used in the city in the four year period have been presented in (Table 23). Among the drugs mentioned, niclosamide (tablet), mebendazole (tablet) and praziquantel (tablet) were the most frequently used drugs with an amount of 2,785,965, 978,060 and 481,320 doses sold. The worth of taenicial drugs used in the four year period, between 2009 and 2012 was 114,600 doses that worth 10,120,112 Eth. Birr.

Table 23: Inventory of annual taenicial drugs dose and their worth in Birr from the year 2009 to 2013 in Addis Ababa.

Name of Taenicial Drug	Unit	Unit Price (Birr)	Year								Total	
			2009		2010		2011		2012		Dose	Worth
			Dose	Worth (Birr)	Dose	Worth (Birr)	Dose	Worth (Birr)	Dose	Worth (Birr)	Dose	Worth (Birr)
Albendazole (Tablet)	Dose	5.50	14,529	78,425	20,259	111,425	26,708	146,894	7,392	40,656	68,618	377,399
Albendazole (syrops)	”	8.95	5,146	46,057	8,119	72,665	1,197	10,713	19,060	170,587	33,522	300,022
Mebendazole (Tablet)	”	1.6	163,280	261,248	368,440	589,504	288,760	462,016	157,580	252,128	978,060	1,564,896
Mebendazole (syrops)	”	5.5	4,800	26,400	39,500	217,250	29,995	164,973	4,171	22,941	78,466	431,563
Niclosamide (Tablet)	”	2.5	1,151,425	2,878,563	437,345	1,093,363	551,000	1,377,500	646,195	1,615,488	2,785,965	6,964,913
Praziquantel (Tablet)	”	4.2	26,500	111,300	47,600	199,920	14,700	61,740	25,800	108,360	114,600	481,320
Total			1,365,410	3,401,992	921,263	2,284,126	912,360	2,223,836	860,198	2,210,159	4,059,231	10,120,112

5. DISCUSSION

Although abattoir-based surveys on livestock diseases have several limitations, they remain an economical way of gathering information (Ansari-Lari, 2005). Infections arising from metacestodes of *T. saginata* (cysticercosis) and *E. granulosus* (hydatidosis) are considered to be an endemic in Ethiopia (Berhe, 2009; Abunna *et al.*, 2011). The present study described the prevalence of metacestodes infection, bovine cysticercosis and hydatidosis, in cattle that were slaughtered at Addis Ababa abattoirs enterprise. It suggested that more cases of metacestodes i.e. from 410 cattle carcasses examined, 26.83% (95% CI = 22.60%-31.40%) were infected with *C. bovis* and 17.07% (95% CI = 13.56%-21.07%) with hydatid cyst.

The prevalence estimate of bovine cysticercosis found in this abattoir-based survey are closely similar to those reported in previous abattoir-based studies from Ethiopia. Abunna *et al.* (2008) reported 26.25% (n=400) in Awassa (the now Hawassa) and Endris and Negussie, (2011) reported 26.7% (n=420) in Kombolcha. However, the present prevalence was higher than that reported by Kebede *et al.* (2008) in Amhara National Regional State (18.49%, n=4,456), Regassa *et al.*, (2009) in Wolaita Soddo (11.3%, n=415) and Taresa *et al.* (2011) in Jimma (3.65%, n=520). Besides, it is higher than 3.19% (n=188) on routine meat inspection and 16.7% (n=792) using Ag-ELISA in Kenya (Asaava *et al.*, 2009), 0.75% (n=1595) in Gambia (Unger *et al.*, 2008) and 3% (n=500) in Iran (Garedaghi *et al.*, 2012). The similarities and differences among the prevalences reported in these studies might be due to resemblances and variations in the origin of slaughtered cattle, sample size, method of detections related to the number of incisions made on the skeletal muscles, husbandry systems of animals, hygienic status and meat eating habits of the residents (Endris and Negussie, 2011; Tolosa *et al.*, 2009).

The prevalence of hydatidosis determined at Addis Ababa abattoirs enterprise is in agreement with the findings of Gebremeskel and Kalayou (2009) in Mekelle (17.6%, n=376), Regassa *et al.* (2009) in Wolaita Soddo (15.4%, n=415) and Kebede *et al.* (2011) in Birre-Sheleko and Dangila (15.2%, n=521) in Ethiopia. Similarly, it is in agreement with the reports from other parts of the world such as Azlaf and Dakkak (2006) in Morocco (22.98%, n=618) and Umur

(2003) in Turkey (13.5%, n=1,355). Nevertheless, the proportion of hydatidosis determined in this study is lower compared to 46.8% (n=852) in Adama (Getaw *et al.*, 2010) and 47.2% (n=320) in Wondo Genet (Octavius *et al.* 2012) from Ethiopia and 23.9% (n=174,034) in Chile (Acosta-Jamett *et al.* 2010) in one hand and it is higher compared to 6.1% (n=4893) Sudan (Omer *et al.*, 2010) and 12% (n=621,686) in Northern Iran (Mansoorlakooraj *et al.*, 2011) on the other hand. The variation in prevalence of cattle hydatidosis between different areas and countries could be attributed to mainly to strains difference in *E. granulosus*, the adult tape worm that exists in different geographical situations (Arene, 1985). Other factors that might have contributed to this variation include differences in agroecology, the time of study, animal husbandry systems, social activity, culture and religion of the society, and attitude to dogs (Macpherson, 1985; Getaw *et al.*, 2010; Octavius *et al.* 2012; Omer *et al.*, 2010; Romig *et al.*, 2011).

With regard to the risk factors of bovine cysticercosis, in the present survey all of the considered environmental and animal characteristics were significantly associated with the prevalence of bovine cysticercosis ($P < 0.05$). The prevalence of cysticercosis was significantly higher in animals obtained from Arsi (35.96%) than that of Borana (13.27%) and Wolaita (17.86%). Cattle from Borana and Wolaita were $0.27 \times$ (95% CI = 0.14 – 0.52) and $0.39 \times$ (95% CI = 0.20 – 0.72) less likely to be infected with *C. bovis* as compared to those from Arsi. These findings are similar to those reported from Ethiopia earlier. Regassa *et al.* (2009) reported that cysticercosis more likely to occur in cattle from Arsi and Gofa than in cattle from Wolaita. Contrary to the results of the present study, several studies indicated insignificant differences in *C. bovis* infection among cattle originated from of different areas of Ethiopia (Abunna *et al.*, 2008; Bedu *et al.*, 2011; Endris and Negussie, 2011). The discrepancy may be attributed to the variation in the sample size proportion of the three origins of cattle (Regassa *et al.*, 2009) and the differences in geographical isolates of the parasite (Pawlowski and Murrell, 2001).

Crossbred Holstein-Frisian cattle showed significantly higher predisposition to *C. bovis* infection than the local indigenous cattle breeds (OR = 2.5; 95% CI = 1.12-5.59; $P = 0.025$). This finding is in line with the observations of Abunna *et al.* (2008) and Regassa *et al.* (2009).

The higher prevalence in crossbred animals may be due to their increased susceptibility to infection than local breeds when exposed to contaminated grazing fields (Abunna *et al.*, 2008). As opposed to the present observation, Kebede *et al.* (2009b) and Swai and Schoonman (2012) found a significantly higher infection in local indigenous cattle breed than crossbreds while Ibrahim and Zerihun (2012) didn't see any significant difference between the two breeds. In areas where they are kept indoors, crossbreed animals show less rate of infection as compared to the local breeds. This is ascribed to their less chance of exposure to parasite ova than pasture grazing animals (Swai and Schoonman, 2012).

Moreover, adult animals (21.99%) showed a significantly lower *C. bovis* infection rates than young animals (37.50%). Adults (≥ 5 years) showed 2.5 times (95% CI = 1.12-5.59) less infection than young animals (<5 years). In conformity with this finding, Endris and Negussie (2011) found a significantly higher infection of *C. bovis* in adults than older animals. Conversely, Ibrahim and Zerihun (2012) and Taresa *et al.* (2011) didn't find age-wise variation in infection rate. The age-wise variation in the prevalence of *C. bovis* observed in this study could be attributed to the age dependent immunity and re-stimulation of immunity from repeated invasions of oncospheres (Wanzala *et al.*, 2003a).

The present survey demonstrated that cattle with medium body condition were 3.49 (1.79-6.78) times more infected with *C. bovis* than those with good body condition (Table 11). Abunna *et al.* (2011) and Regassa *et al.*, (2009) have reported a similar observation. The higher infection rate encountered in animals with medium body condition has been attributed to the relative ease to detect *C. bovis* in less fleshed animals as compared to well-fleshed animals (Abunna *et al.*, 2011).

An assessment on the association between origin, breed, age and body condition and hydatidosis revealed that origin and age of animals were significantly associated with prevalence of bovine hydatidosis ($P < 0.05$). A univariate analysis has revealed that cattle from Borana were $0.31 \times$ (95% CI = 0.14-0.68) less infected than those from Arsi. Likewise, a higher prevalence of hydatidosis was observed in cattle obtained from Arsi than those from Gofa and Wolaita (Regassa *et al.*, 2009). Moreover, Abebe *et al.* (2013) observed greater

infection in cattle from Fogera than that of Debarq. This variation has been ascribed to strain differences of *E. granulosus* (McManus, 2006).

The present data showed that adult cattle (≥ 5 years) were more frequently affected than young animals (< 5 years) (OR = 2.02; 95% CI = 1.08-3.78; $P = 0.028$). A similar observation has been reported by Zewedu *et al.* (2010), Abebe *et al.*, (2013), Negash *et al.* (2013) Umur (2003) and Esatgil and Tuzer (2007). The age-wise variation in infection rate could be mainly due to longer exposure time to *E. granulosus* (Zewedu *et al.* (2010). Disparately, Melaku *et al.* (2012) and Abunna *et al.* (2011) demonstrated statistically insignificant variation among the two age groups considered.

Among the different characteristics considered in the present study, breed and body condition of cattle were not significantly associated with the proportion of infection of hydatidosis ($P > 0.05$). A similar finding has been documented by Berhe (2009). Differently, a survey made by Regassa *et al.* (2009) and documented the occurrence of hydatidosis at higher prevalences in crosses than the local indigenous breeds of cattle while Bekele and Butako (2011) and Swai and Schoonman (2012) observed a significantly higher infection rate among local indigenous breed of cattle than crossbred animals.

In agreement with the study result Abunna *et al.* (2011), Bekele and Butako (2011) and Abunna *et al.* (2012) didn't observe variation in the level of infection associated with the body condition of cattle. In contrast, Berhe (2009) noted that medium body conditioned animals contained hydatid cysts more frequently than animals with good body condition and Melaku *et al.* (2012) have recorded that animals with poor medium condition harbor hydatid cyst more commonly than medium and good medium condition.

In order to work out guidelines for the routine diagnosis of cysticercosis, it is important that the predilection sites of cysticerci in cattle are determined (Maeda *et al.*, 1996). In this study, the heart, shoulder and masseter muscles were the most frequently *C. bovis*, infected tissues with a respective relative infection rates of 31.79%, 25.17% and 23.84% (Table 13) similar to the reports of Abunna *et al.* (2008), Tolosa *et al.* (2009), Maeda *et al.* (1996) and Garedaghi *et*

al. (2012). It appears that several factors such as activity of the muscles, age and the geographical area area concerned determine largely the predilection sites in slaughtered cattle (Petrovic, 1976; Minozzo *et al.*, 2002; Opara *et al.*, 2006).

From a total of 400 *C. bovis* cysts that were collected from different organs harbouring them, 39% and 31.5% were obtained from the heart and masseter muscle. The mean count of *C. bovis* was higher in the heart, liver and masseter muscle bearing 3.25, 3.2 and 3.5 cysts per infected organ or tissue (Table 17). Up on viability analysis 191 (47.75%) cysts were alive while 209 (52.25%) were dead (Table 20). From the viable cysts 17% and 14.75% were obtained from the heart and masseter muscles respectively. Similarly, majority of the non-viable cysts were encountered in the heart and masseter muscles consisting 22.25% and 16.5% of the dead cysts in that order. Similar to this finding, Abunna *et al.* (2008) have recorded that from the total viable cysts 29.4% (n=221) were obtained from the heart and 43% (n=151) of heart cysts were alive. The presence of high number of viable cysts in the tissues examined indicates the existence of a threat to the public residing in Addis Ababa due to their habit of eating raw meat.

In this study, the lung and liver were found more frequently affected with hydatid cyst than the remainder with a respective proportion of 56.25% and 23.44% of infected organs respectively (Table 14). This is in agreement with the findings of Bekele and Butako (2011), Njoroge *et al.* (2002) and Eckert and Deplazes (2004). The average count of hydatid cyst recorded was higher in the lung (5.13) followed by liver (3.37), kidney (1.3), heart (1) and spleen (1) (Table 15). Data on the size of hydatid cysts are shown in Table 18. From 500 cysts collected and examined for the status of fertility, sterility, or calcification, 112 (22.4%) were calcified, 219 (43.8%) sterile, and 169 (33.8%) fertile (Table 20). And out of 169 fertile cysts 58 (34.3%) were live whereas 111 (65.7%) dead. The majority of viable and cysts were obtained from the lung that were 29.6% and 55% respectively.

In this study, from a total of 110 interviewed persons in this study, 70 (63.64%; 95% CI: 53.92% -72.60%) disclosed they have contracted infection (Table 22). The present finding is in conformity with questionnaire survey results of Abunna *et al.* (2008) in Awassa (64.2%, n =

120), Bedu *et al.*, 2011) in Zeway (56.78%, n = 120) and Taresa *et al.* (2011) in Jimma (64.44%, n = 116). However, it is higher than the proportion determined in Ethiopia by Abunna *et al.* (2011) in Nekemete (9.72%, n = 72) and Endris and Negussie (2011) in Kombolcha (31%, n = 200) using similar methods. However, prevalences of taeniosis determined in cross-sectional surveys of human taeniosis using stool examination in Ethiopia such as 0.8% (n=248) in Bahir Dar (Alemu *et al.*, 2011), 5.3% (n = 704) in North Gondar (Ayalew *et al.*, 2011), 1.4% (n = 419) in Bushulo rural town along the shore of the Lake Awassa (Terefe *et al.*, 2011) and 7.0% (n = 15) in Gondar (Abate *et al.*, 2012), were much lower than those obtained by questionnaire surveys. Similarly, reports from outside Ethiopia such as by Asaava *et al.* (2009) in Northern Turkana District Kenya (2.5%, n = 241 also) and indicated that prevalence of taeniosis disclosed by microscopy is much lower than the results of the questionnaire survey.

Taenia saginata infection showed a significant sex-wise variation among the residents of Addis Ababa. Females were 0.24 times (95% CI= 0.11-0.55) less likely to be infected than their male counterparts. Also, age-wise variation was observed by Megersa *et al.* (2010). This could be due to economic and cultural taboos that discouraged females from eating raw meat in butchers and restaurants as compared males (Megersa *et al.*, 2010). However, as opposed to the findings of the present study, Abunna *et al.* (2008), Bedu *et al.* (2011) and Tesfaye *et al.* (2012) recorded insignificant differences between the two sex groups in their exposure to taeniosis.

The proportion of infection with *T. saginata* varied significantly among the different age groups, religion, occupation, meat eating habits and uses of spices considered in the study ($P < 0.05$). However, marital status and type of education are insignificantly associated with the prevalence of taeniosis ($P > 0.05$).

Among the different age groups, those between 15 and 26, 27 and 40, and above 40 years were 10.83 (95% CI = 2.05-57.27), 14.17 (95% CI = 2.717-4.11) 6.67 (95% CI = 1.05-42.43) times more infected respectively than those below 15 years. In conformity with this finding, Regassa *et al.* (2009), Taresa *et al.* (2011) and Tesfaye *et al.* (2012) have reported that the disease is

more common in adults than in children and youth. The possible explanation for the presence of age-wise variation in the prevalence of taeniosis is attributed to frequent raw meat eating habit of adults as compared to those below 15 years (Megersa *et al.*, 2010). Nevertheless, Abunna *et al.* (2011) and Bedu *et al.* (2011) didn't observe age-wise variation in the proportion of taeniosis.

From the two religious groups, Christians were more prone to beef tapeworm infection than Muslims ($P < 0.05$). Christians were 4.74 (95% CI = 1.61-13.94; $P = 0.005$) times more infected than Muslims. Also, Abunna *et al.* (2008), Regassa *et al.* (2009) and Taresa *et al.* (2011) indicated a similar observation. Nonetheless, Bedu *et al.*, (2011) and Megersa *et al.* (2010) didn't find any variation in the level of infection between the two religious groups. The higher infection rate seen among Christians is associated with their habit of consuming raw meat as compared to the Muslims.

High risk groups that have frequent exposure too cattle meat and their products, raw meat eaters, and those who use spice showed 8.17 (95% CI = 3.25-20.54; $P = 0.000$), 14.29 (95% CI = 5.92-34.42; 0.000) and 2.59 (95% CI = 1.17-5.76; $P = 0.019$) times more infection with *C. bovis* than low risk groups, cooked meat eaters and those who do not use spice respectively. In agreement with these findings, Abunna *et al.* (2008), Megersa *et al.* (2010), Bedu *et al.* (2011), Endris and Negussie, (2011), Taresa *et al.* (2011) and Tesfaye *et al.* (2012) have reported that *Taenia saginata* infection is higher in raw meat eaters as compared to those of cooked meat eaters and in high risk groups than those of less risk groups.

Drug inventory has showed that niclosamide (tablet), mebendazole (tablet) and praziquantel (tablet) were the most frequently used drugs with an amount of 2,785,965, 978,060 and 481,320 doses sold. The worth of taenicial drugs used in the four year period, between 2009 and 2012 was 114,600 doses that worth 10,120,112 Eth. Birr. Bedu *et al.*, 2011 indicated that the utilization of 74,614 adult taenicial drug doses with an estimated cost of 110,560 Eth. Birr in two years' time in Zeway town and Tesfaye *et al.* (2012) also revealed the consumption of 29,952 adult doses which worth 40,201.8 Eth. Birr (2407.2 USD) per annum in Wolaita Soddo. All the existing reports in Ethiopia revealed that a huge sum of family and

country money is spent for the purchase of taenicial drugs that would have been spent on other important items.

5.1 Conclusion and Recommendations

Metacestodes in cattle is a problem of both economic and public health importance in many parts of the world, including Ethiopia. Significant economic losses are associated with condemnation and trimming of cattle carcasses and edible organs such as liver. Besides the development of either the metacestodes the human tapeworm, *Taenia saginata*, or *E. granulosus* or in human consists of public health significance. In the present study it was determined that the prevalence of metacestodes infection in cattle is significantly higher in animals brought from Arsi, Wolaita and Borana and they are responsible for the condemnation of enormous number offals and viscera. The rate of infection of metacestodes was found significantly varying with the origin and age of cattle. A number of residents of Addis Ababa disclosed they were infected with the tapeworm *T. saginata* and male, adults and old age groups, Christians, high risk groups, raw meat eaters and those that use spices were the most vulnerable groups to *T. saginata* infection. The drug inventory also showed that many doses of taenicial drugs that cost a huge sum of money were sold to the public. Thus, metacestode infection is a major problem among cattle brought from Arsi, Wolaita and Borana and slaughtered at Addis Ababa abattoirs enterprise. Apart from these a huge number of the public experiences taeniosis and expend the family money from the purchase of taenicial drugs.

Based up on the findings of the present study, the following measures are recommended:-

- Infected meat and meat products must undergo the proper process of freezing, boiling or destruction based on the intensity of infection with cysticerci.
- Offals found infected with hydatid cyst must be properly disposed via through burying or incineration.
- Regular deworming of dogs using suitable taenicial or taenifuge is essential.

- There should be public health awareness about the health and economic significance of the disease with special reference to the danger of consumption of either raw or undercooked meat and on maintaining high standards of personal hygiene through the use of latrines.

6. REFERNCES

- AACA. (2004): Addis Ababa City Administration.
- Abate E., Belayneh M., Gelaw A., Idh J., Getachew A., *et al.* (2012): The Impact of Asymptomatic Helminth Co-Infection in Patients with Newly Diagnosed Tuberculosis in North-West Ethiopia. *PLoS ONE*, **7**(8):e42901. doi:10.1371/journal.pone.0042901.
- Abel M. (1985): Bovine Echinococcosis and its public health significance at Wolaita Sodo. DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre-Zeit, Ethiopia.
- Abunna F., Ayala D., Regassa, A., Megersa B. and Debela E. (2011): Major Metacestodes in Cattle Slaughtered at Nekemte Municipal Abattoir, Western Ethiopia: Prevalence, Cyst Viability, Organ Distribution and Socioeconomic Implications) *BIOMIRROR*, **1-7/** bm-0929100511.
- Abunna F., Fentaye S., Megersa B. and Regassa A. (2012): Prevalence of bovine hydatidosis in Kombolcha ELFORA abattoir, North Eastern Ethiopia. *Open Journal of Animal Sciences*, **2**(4):281-286.
- Abunna F., Tilahun G., Megersa B., Regassa A. and Kumsa B. (2008): Bovine Cysticercosis in Cattle Slaughtered at Hawassa Municipal Abattoir, Ethiopia: Prevalence, Cyst Viability, Distribution and its Public Health Implication. *Zoonoses and Public Health*, **55**:82-88.
- Acosta-Jamett G., Cleaveland S., Cunningham A.A., Bronsvort B.M.deC. and Craig P.S. (2010): *Echinococcus granulosus* infection in humans and livestock in the Coquimbo region, north-central Chile. *Veterinary Parasitology*, **169**:102-110.
- Adebolu T.T. and Badmus N.A. (2004): Comparative study on intestinal parasites amongst secondary school pupils in Ikare Akoko, Ondo State, Southwestern Nigeria. *J. F. Agri Envi*, **2**:10-13.
- Akhtar M.S. and Ahmad I. (1992): Compaative efficacy of *Mallotus Philippinesis* fruit (Kalmala) or Nilzan drug against gastrointestinal cestodes in beetal goats. *Sm. Rum. Res*, **8**:121-128.

- Alemayehu L. (1990): The prevalence of hydatidosis in cattle sheep and goats, *Echinococcus granulosus* in dogs in Arsi Administrative Region. DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia.
- Alemu A., Shiferaw Y., Getnet G., Yalew A. and Addis, Z. (2011): Opportunistic and other intestinal parasites among HIV/AIDS patients attending Gambi higher clinic in Bahir Dar city, North West Ethiopia. *Asian Pacific Journal of Tropical Medicine*, 661-665.
- Amsalu D. (1989): prevalence and significance of *C. bovis* among slaughtered cattle at Debre zeit abattoir. Faculty of vererinary Medicine, Addis Ababa University, debre Zeit, Ethiopia, DVM Thesis.
- Andersen F.L. (1998): Introduction to cystic echinococcosis and description of co-operative research project in Morocco. In; Andersen, F.L., Ouhelli H. and Kachani M. (Eds). Compendium on cystic echinococcosis. Brigham Young University Press, Utah.
- Anoskie J.C. (2011): Some observations on *Taenia saginata* cytsicercosis in slaughter cattle in Nigeria. *International J. Zooneses*. **2**:82-89.
- Ansari-Lari M. (2005): A retrospective survey of hydatidosis in livestock in Shiraz, Iran, based on abattoir data during 1999 – 2004. *Vet. Parasitol*, **133**:119-123.
- Antia R.E. and Alonge D.O. (1982): survey of abattoir data in southern Nigeria. *Trop. Anim. Hlth Prod*, **14**:119-120.
- Arene F.A.I. (1995): Prevalence of hydatidosis in domestic livestock in the Niger Delta. *Trop. Anim. Hlth Prod*. **17**:3-5.
- Arudkil J.H. and Adolph A.J. (1980): preliminary observation on removal of *T. saginata* egg from sewage using various treatment processes. *Aust. Vet. J*, **56**(10):492-495.
- Asaava L.L., Kitala P.M., Gathura P.B., Nanyingi M.O., Muchemi G. and Schelling E. (2009): A survey of bovine cysticercosis/human taeniosis in Northern Turkana District, Kenya. *Preventive Veterinary Medicine*, **89**:197-204.
- Ayalew A., Debebe T. and Worku A. (2011): Prevalence and risk factors of intestinal parasites among Delgi school children, North Gondar, Ethiopia. *J. Parasitol. Vector Biol*, **3**:75-81.
- Azizi F., Janghorbani M. and Hatami H. (2000): Epidemiology and control of common disorders in Iran. 2nd ed. Eshtiagh Publication, Tehran. 558p.

- Azlaf R. and Dakkak A. (2006): Epidemiological study of the cystic echinococcosis in Morocco. *Veterinary Parasitology*, **137**:83-93.
- Bartake J., Sterba J., Prokopic J. and Scyhandl V. (1982): Economic losses due to cysticercosis in cattle. *Vet. Med. (Praha)*, **27**:525-530.
- Bedu H., Tafess K., Shelima B., Woldeyohannes D., Amare B., *et al.* (2011): Bovine Cysticercosis in Cattle Slaughtered at Zeway Municipal Abattoir: Prevalence and its Public Health Importance. *J. Veterinar. Sci. Technol*, **2**:108. doi:10.4172/2157-7579.1000108.
- Bekele J. and Butako B. (2011): Occurrence and financial loss assessment of cystic echinococcosis (hydatidosis) in cattle slaughtered at Wolayita Sodo municipal abattoir, Southern Ethiopia. *Trop. Anim. Health Prod*, **43**:221-228.
- Berhanu A. and Ermias D. (1978): Comparative Bioassay studies of some traditional antehelminthics plants, plant extract modern drugs. *Eth. J. Sci*, **1**(2):22-24.
- Berhe G. (2009): Abattoir survey on cattle hydatidosis in Tigray Region of Ethiopia. *Trop Anim Health Prod*, **41**:1347-1352.
- Biru G. (1984): A handbook on Veterinary Helminthology. Lesotho agricultural college, Instruction materials and resource center, Maseru, Lesotho, South Africa. Pp. 331
- Blazek S. and Schramlova J. (1983): Morphology of *Cysticercus* during its development folia. *Parasitol(praha)*, **30**:335-339.
- Bowman D.D. (1999): Cestodes. In: Bowman, D.D. and Lynn, R.C. (Eds); Georgi's parasitology for veterinarians. Pp. 124-143. WB Saunders, Philadelphia, PA.
- Bronshtein A.M., Melnikova L.I., Firsova R.A. and Legonkov I.A. (1993): an analysis of the results of clinical trials of Praziquantel analogs in intestinal cestodes and trematode infections. The treatment of intestinal cestodes infections (diphyllobothriasis, Taeniosis, hymenolepiasis). *Med. Parazitol, (Mosk)*. **1**:27-29.
- Cabaret J., Geerts S., Madeline M., Ballandone C. and Barbier D. (2002): The use of urban sewage sludge on pastures: the cysticercosis threat. *Vet. Res*, **33**:575-597.
- CDC. (2000): [http://www: dpd.cdc.gov.dpd](http://www.dpd.cdc.gov.dpd).
- Chandler A.S.A.C., Read P. and Clark A. (1961): Introduction to parasitology with special reference to the parasite of man. 10th ed. John Wiley and Sons, Inc., New York, Pp. 361-367.

- Charles M. and Hendrix C.M. (1998): Diagnostic Veterinary Parasitology. 2nd Ed. Mosby, Inc. London, Pp. 128-143.
- Cheruiyot H.K. and Onyango-Abuje J.A. (1984): Taeniosis and cysticercosis in Kenya; A review. *Trop. Anim. Hlth prod.* **16**: 29-33.
- CTA. (1989): Manual of Tropical Veterinary Parasitology. 2nd edition, Cambrian Printers, UK.
- Dada B.J.O. (1978): Incidence of hydatid disease in camels slaughtered at Kano abattoir. *Trop. Anim. Hlth. Prod.*, **10**: 204.
- Dalimi A.A., Motamedi Gh.G., Hosseini M.M., Mohammadian B.B., Malaki H.H., Ghamari, Z.Z. and Far F.F.G. (2002): Echinococcosis/hydatidosis in western Iran. *Vet. Parasitol.*, **105**:161-71.
- Dawit S. (2004): Epidemiology of *T. saginata* taeniasis and Cysticercosis in North Gondor Zone, Northwest Ethiopia. Faculty of Veterinary Medicine, Addis Ababa University, Debre Zeit, Ethiopia, Unpublished DVM Thesis.
- Desta B. (1995): Ethiopian Traditional Herbal drugs, Part I: Studies on the toxicity and therapeutic activity of local taenicidal medication. *J. Ethn. Pharm.*, **45**:27-33.
- Dorny P., Phiri I.K., Vereruyse J., Gabriel S., Willingham A.L., Brandt J., Victor B., Speybroeck N. and Berkvens D. (2004): a Bayesian approach for estimating values for prevalence and diagnostic test characteristics of porcine cysticercosis. *Int. J. Parasitol.*, **34**:569-576.
- Dunn A.M. (1978): Veterinary Helminthology. 2nd Ed, London, Balter and Tanner, Ltd., Pp. 276-278.
- E.C. (2000): Opinion of the scientific committee on veterinary measures relating to public Health on the control of taeniosis/cysticercosis in man and animals (adopted on 27-28 September 2000). Available online at http://ec.europa.eu/food/fs/sc/scv/out36_en.pdf
- E.C. (2000): Taeniosis/cysticercosis. In: Opinion of the scientific committee veterinary Measures relating to public health on the control of taeniosis/ cysticercosis in man and animals.
- Eckert J. (1996): Workshop Summary: Food Safety, meat and fishborn zoonoses. *Vet. Parasitol.*, **64**:143-147.

- Eckert J. and Deplazes P. (2004): Biological, epidemiological and clinical aspects of echinococcosis, a zoonosis of increasing concern. *Clinical Microbiology Reviews*, **17**:107-135.
- Endris J. and Negussie H. (2011): Bovine cysticercosis: prevalence, cyst viability and distribution in Cattle slaughtered at Kombolcha Elfora Meat Factory, Ethiopia. *American-Eurasian J. Agric and Environ. Sci*, **11**:173-176.
- Ensminger M.E. (1992): Age Determination in Beef Cattle. The Stockman's Handbook. 7th Ed, Pp. 1-5.
- Eom K.S. and Rim H.J. (1993): Morphologic descriptions of *Taenia asiatica*. *Kor. J. Parasitol*, **31**:1-6.
- Eom K.S., Rim H.J. and Geerts S. (1992): Experimental infections of pigs and cattle with eggs of asian taenia saginata with special reference to its extra hepatic viscera tropism. *Kor. J. parasitol*, **30**:269-275.
- Erko B. and Medhin G. (2003): Human helminthiasis in Wondo Genet, southern Ethiopia, with emphasis on geohelminthiasis. *Ethiop. Med. J*, **41**:333-344.
- Esatgil M.U. and Tuzer E. (2007): Prevalence of hydatidosis in slaughtered animals in Thrace, Turkey. *Turkiye Parazitoloji Dergisi*, **31**:41-45.
- Fan P C. (1988): Taiwan *Taenia* and taeniasis. *Parasitol. Today*, **4**:86-88.
- Fan P.C., Chung W.C., Lin C., Y.B. and Wu C.C. (1990): the pig as an intermediate host for Taiwan taenia infection. *J. Helminthol*, **64**:223-231.
- Fan P.C., Lin C.Y., Chen C.C. and Chung W.C. (1995): Morphological description of *Taenia saginata asiatica* (Cyophyllidea: taeniidae) from man in Asia. *J. Helminthol*, **69**:299-303.
- Fertig D.L. and Dorn C.R. (1985): *Taenia saginata* cysticercosis in an Ohio cattle feeding operation. *J. Am. Vet. Med. Assoc*, **1985**:1281-1286.
- Feseha G. (1995): Zoonotic disease in Ethiopia. Ethiopian veterinary association Proceeding of 9th conference, June 8, Pp. 22-38.
- Fikire Z., Tolosa T., Nigussie Z., Macias C. and Kebede N. (2012): Prevalence and characterization of hydatidosis in animals slaughtered at Addis Ababa abattoir, Ethiopia. *Journal of Parasitology and Vector Biology*, **4**:1-6.

- Frolova A.A. (1982): Taeniasis control in the USSR. In: Lysenko, A. (ed.); Zoonoses Control. Vol. II, Moscow: UNEP publication, Pp. 192-235.
- Garedaghi Y., Saber A.P.R. and Khosroshahi M.S. (2012): Prevalence of Bovine cysticercosis of slaughtered cattle in Meshkinshahr abattoir, Iran. *Journal of Animal and Veterinary Advances*, **11**:785-788.
- Gebre Emanuel T. (1997): food hygiene principles and method of food borne disease control with special reference to Ethiopia, Addis Ababa, Faculty of Medicine, Department of Community Health, Addis Ababa, Faculty of Medicine, Department of Community Health, Addis Ababa University, Pp. 104-105.
- Gebremeskel B. and Kalayou S. (2009): Prevalence, viability and fertility study of bovine cystic echinococcosis in Mekelle city, Northern Ethiopia. *Revue Méd. Vét*, **160**:92-97.
- Geerts S. (1992): *T. saginata* Knaagtaan Kwaliteit Van Rundvlees. *Agricontact*. 236, VIIa, Pp. 1-6.
- Getachew J. (1991): The prevalence of hydatidosis in cattle at Awassa abattoir. DVM Thesis. Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia.
- Getaw A., Beyene D., Ayana D., Megersa B. and Abunna F. (2010): Hydatidosis: Prevalence and its economic importance in ruminants slaughtered at Adama municipal abattoir, Central Oromia, Ethiopia. *Acta Tropica*, **113**:221-225.
- Ghai O.P. (2000): Essential preventive Medicine, A clinical and applied orientation. Vikas Publishing.
- Giesecke W.H. (1997): Prevalence and economic implications of taeniasis/cysticercosis in South Africa. In: Cysticercosis. Report on a Workshop Held at the Onderstepoort Veterinary Institute. Onderstepoort, South Africa, August 18-19, 1997, Pp. 19-70.
- Gracey F.J. and Collins S.D. (1992): Meat Hygiene. 5th Ed. Baillière Tindall, 24-28 Oval Road, London NW17DX, Pp. 413-420.
- Gracey J.F., Collins D.S. and Huey R.J. (1999): Meat Hygiene, 3rd edition. W.B. Saunders Company Ltd, Pp. 669-678.
- Grant P.S. and McManus D.P. (2003): Parasitology: Echinococcosis transmission, biology and epidemiology, Cambridge University Press. 127p.
- Grindle R.J. (1978): Economic Losses Resulting From Bovine Cysticercosis with Reference to Botswana and Kenya. *Tropical Animal Health and Production*, **10**:127-140.

- Hagos B., Mesfin M. and Abebe B. (2006): Hydatid disease of the liver: A 12 year experience of surgical management. *East Cent. Afr. J. Surg.*, **11**:54-56.
- Hailu D. (2005): Prevalence and risk factors for *T. saginata* cysticercosis in three selected areas of eastern Shoa, M.Sc thesis. Faculty of Veterinary Medicine, Addis Ababa University, Debre Zeit, Ethiopia, Unpublished MSc Thesis.
- Hancock D.D., Swikse E. and Lichtenwalner A.B. (1989): Distribution of Bovine Cyst in Washington. *American. Journal Veterinary Res*, **50**:564-570.
- Helle O., Velle W. and Tharaldsen J. (1989): Effect of ovine urine and some of its components on viability of nematode eggs and larvae in sheep faeces. *Vet. Parasitol*, **32**:349-354.
- Helle O., Velle W. and Tharaldsen J. (1989): Effect of ovine urine and some of its components on viability of nematode eggs and larvae in sheep faeces. *Vet. Parasitol*, **32**:349-354.
- Hendrix C.M. (1998): Diagnostic Veterinary Parasitology. 2nd Ed. Elsevier, USA. 352p.
- Ibrahim N. and Zerihun F. (2012): Prevalence of *Taenia saginata* sycsticercosis in Cattle Slaughtered in Addis Ababa Municipal Abattoir, Ethiopia. *Global Veterinaria*, **8**:467-471.
- Ilsøe B., Kyvsgaard N.C., Nansen P. and Henriksen S.A. (1990): Bovine cysticercosis in Denmark. A study of possible causes of infection in farms with heavily infected animals. *Acta Vet. Scand*, **31**:159-168.
- Ito A.A., Plancarte A., *et.al.* (1998): Novel antigens for neurocysticercosis; simple methods for preparation and evaluation of serodiagnosis. *Am. J. Trop. Med. Hyg*, **59**:291-294.
- Jenberie S., Awol N., Ayelet G., Gelaye E., Negussie H. and Abie G. (2011): Gross and histopathological studies on pulmonary lesions of camel (*Camelus dromedarius*) slaughtered at Addis Ababa abattoir, Ethiopia. *Trop. Anim. Health Prod*, doi 10.1007/s11250-011-9977-z.
- Jenkins D.J. (2005): Hydatid control in Australia: where it began, what we have achieved and where to from here. *Int. J. Parasitol.*, **35**:733-740.
- Jeon H.K. and Eom K.S. (2006): *Taenia asiatica* and *Taenia saginata*: Genetic divergence estimated from their mitochondrial gnomes. *Experimental Parasitology*, **113**:58-61.
- Jobire Y., Lobagho F., Tirune, R., Abeb, G. and Dorchie, Ph. (1996): Hydatidosis in three selected regions in Ethiopia: an assessment trial on its prevalence, economic and public health importance. *Revue de Medecine Veterinaire*, **147**:797-804.

- Juris P., Vasilkova Z., Plachy P., Krupicer I. and Sokol J. (1996): Coccidial oocysts in cattle slurry on farms in north-eastern Slovakia. *Slov. Vet. Casopis*, **21**:93-95.
- Kambarage D. (1995): East Coast fever as a continued constraint to livestock improvement in Tanzania: a case study. *Trop. Anim. Health. Prod.*, **27**:145-149.
- Kates K.C. (1950): Survival on pasture of free-living stages of some common gastrointestinal nematodes of sheep. *Proceedings of the Helminthological Society of Washington*, **17**:39-58.
- Kaufmann J. (1996): Parasitic Infections of domestic animals. A diagnostic manual. Birkhäuser Verlag, Basel, Schweiz. 423 p.
- Kebede N. (2008): Cysticercosis of slaughtered cattle in northwestern Ethiopia. *Research in Veterinary Science*, **85**:522-526.
- Kebede N., Abuhay A., Tilahun G. and Wossene A. (2009a): Financial loss estimation, prevalence and characterization of hydatidosis of cattle slaughtered at Debre Markos Municipality abattoir, Ethiopia. *Trop. Anim. Health Prod.*, **41**:1787-1789.
- Kebede N., Gebre-Egziabher Z., Tilahun G. and Wossen A. (2011): Prevalence and Financial Effects of Hydatidosis in Cattle Slaughtered in Birre-Sheleko and Dangila Abattoirs, Northwestern Ethiopia. *Zoonoses Public Health*, **58**:41-46.
- Kebede N., Tilahun G. and Hailu A. (2009b): Current status of bovine cysticercosis of slaughtered cattle in Addis Ababa Abattoir, Ethiopia. *Trop Anim Health Prod.*, **41**:291-294.
- Lightowlers M.W., Rolfe R. and Gauci C.G. (1996): *Taenia saginata*: Vaccination against cysticercosis in cattle with recombinant oncosphere antigens. *Experimental Parasitology*, **84**:330-338.
- Lloyd S., Walters T.M.H. and Craig P.S. (1998): Use of sentinel lambs to survey the effect of an education programme on control of transmission of *Echinococcus granulosus* in South Powys, Wales. *Bull. W.H.O.*, **76**:469.
- Macpherson L.N.L. (1985): Epidemiology of hydatid disease in Kenya. A study of domestic intermediate hosts in Masailand. *Transac. Royal Soc. Trop. Med. Hyg.*, **79**:209-217.
- Maeda G.E., Kyvsgaard N.C., Nansen P. and Bøgh H.O. (1996): Distribution of *Taenia saginata* cysts by muscle group in naturally infected cattle in Tanzania. *Preventive Veterinary Medicine*, **28**:81-89.

- Mamo B., Assefa B. and Lo C.T. (1989): Intestinal helminths in Akaki town, with special emphasis on the epidemiology of *Schistosoma mansoni*. *Ethiop. Med. J*, **27**:183-191.
- Mamo E. (1988): Some common Zoonotic helminthes. In: Zein A.Z. and Kool H. (Eds). The Ecology of Health. Ministry of health, Addis Ababa, Pp. 231-243.
- Mango A.M., Mango C.K.A. and Kariuki D. (1974): Prevalence of selected common parasitic helminths of livestock in Kenya. *Veterinary Record*, **94**: 432–435.
- Mansoorlakoaraj H., Saadati D., Javadi R., Heydari S., Torki E., Gholami H., Mazaheri R. and Fard N. (2011): A survey on hydatidosis in livestock in Northern Iran based on data collected from slaughterhouses from 2004 to 2008. *Veterinary Parasitology*, **182**:364-367.
- Mayta H., Talley A., Gilman R.H., *et al.*, (2000): Differentiating *Taenia solium* and *Taenia saginata* infections by simple hematoxylin-eosin staining and PCR restriction enzyme analysis. *J. Clin. Microbiol*, **38**:133-137.
- McFadden A.M.J., Heath D.D., Morley D.D. and Dorny P. (2011): Investigation of an outbreak of *Taenia saginata* cysts (*Cysticercus bovis*) in dairy cattle from two farms. *Veterinary parasitology*, **176**:177-184.
- McManus D.P. (2006): Molecular discrimination of taeniid cestodes. *Parasitology International*, **55**:31-37.
- Megersa B., Tesfaye E., Regassa A., Abebe R. and Abunna F. (2010): Bovine cysticercosis in Cattle Slaughtered at Jimma Municipal Abattoir, South western Ethiopia: Prevalence, Cyst viability and Its Socio-economic importance. *Veterinary World*, **3**: 257-262.
- Melaku A., Lukas B., and Bogale B. (2012): Cyst Viability, Organ Distribution and Financial Losses due to Hydatidosis in Cattle Slaughtered at Dessie Municipal Abattoir, North-eastern Ethiopia. *Vet. World*, **5**:213-218.
- Minozzo J.C., Gusso R.L.F., de Castro E.A., Lago O. and Soccol V.T. (2002): Experimental bovine infection with *Taenia saginata* eggs: recovery rates and cysticerci location. *Braz. Arch. Biol. Technol*, **45**:4.
- Mobius G. (1993): Epidemiologische Untersuchungen Zum *C. bovis* and *Taenia saginata* Befall in den ostund westdeutschen Landern. *Dtsch Tierartzl. Wschr*, **100**:110-114.

- Mohammed A. (1988): Study on prevalence and economic significance of bovine hydatidosis in Gamogofa region. DVM thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia.
- Mosienyane M.G. (1986): A survey of *Cysticercus bovis* (measles) infestation in cattle sent for slaughter to Botswana Meat Commission (BMC). A ten years retrospective study 1974-1983. *Int. J. Zoonoses*, **13**(2):124-130.
- Negash K. Beyene D. and Kumsa B. (2013): Cystic echinococcosis in cattle slaughtered at Shashemanne Municipal Abattoir, south central Oromia, Ethiopia: prevalence, cyst distribution and fertility. *Royal Society of Tropical Medicine and Hygiene*, Available online on <http://trstmh.oxfordjournals.org>. Downloaded on February 14, 2013.
- Nicholson M.J. and Butterworth M.H. (1986): A guide to condition scoring of zebu cattle international livestock center for Africa, Addis Ababa Ethiopia.
- Nigatu Kebede. (2004): *Cysticercus bovis*: development and evaluation of serological tests and prevalence at Addis Ababa abattoir. M.Sc. thesis, Faculty of Veterinary Medicine, Addis Ababa University
- Njoroge E.M., Mbithi P.M., Gathuma J.M., Wachira T.M., Magambo J.K. and Zeyhle E. (2002): A study of cystic echinococcosis in slaughter animals in three selected areas of northern Turkana, Kenya, *Veterinary Parasitology*, 104p.
- NMSA (National Meteorology Service Agency). (1999): Monthly Climate Bulletin, Addis Ababa Branch, Addis Ababa, Ethiopia, 7p.
- Nunes C.M., Biondi G.F., Heinkemann M.B. and Richtzenhain L.J. (2000): Comparative evaluation of an indirect ELISA test for diagnosis of swine cysticercosis employing antigen from *Taenia solium* and *Taenia crassiceps* metacestodes. *Vet. Parasitol*, **93**:135-140.
- Octavius J., Nigatu K., Tesfu K., Getachew T. and Chanda M. (2012): Occurrence of bovine hydatidosis and evaluation of its risk to humans in traditional communities of Southern Region of Ethiopia. *Ethiop. J. Health Dev*, **26**:43-48.
- Ogurinade A.F. and Oyekele O.D. 1990. Evaluation of the efficiency of beef inspection procedure for tuberculosis, fascioliasis and cysticercosis in a Nigerian abattoir. *Preventive Veterinary Medicine*, **8**:71-75.

- OIE. (2001). *Handistatus II*. OIE (Office of International des Epizooties) Paris, France. www.oie.int.
- OIE. (2004): Cysticercosis: In: Manual of Diagnostic Tests and Vaccines for Terrestrial Animals, http://www.oie.int/eng/normes/mmanual/A_00127.htm.
- Okolo M.I.O. (1986): Observation on *Cysticercus cellulosae* in the flesh of rural dogs. *Int. J. Zoonosis*, **13**:286-289.
- Oladele D., Gracey M., Brad S., Stany G., and Jef B. (2004): Bovine Cysticercosis: Preliminary Observations on the Immuno-histochemical Detection of *Taenia saginata* Antigens in Lymph nodes of an Experimentally Infected Calf. *Canadian Veterinary Journal*, **45**:852-855.
- Olteanu, G.(1982):Economicimplication of cysticercosis in cattle.The first international symposium in human taeniasis and cattle cysticercosis, Czechoslovakia.
- Omer R.A., Dinkel A., Romig T., Mackenstedt U., Elnahas A.A., Aradaib I.E., Ahmed M.E., Elmalik K.H. and Adame A. (2010): A molecular survey of cystic echinococcosis in Sudan. *Veterinary Parasitology*, **169**:340-346.
- Onyango-Abuje J.A. (1984): Separation of *Taenia saginata* oncospheres from faecal debris. *J. Parasitol.*, **70**:146-148.
- Opara M.N., Ukpong U.M., Okoli I.C. and Anosike J. (2006): Cysticercosis of slaughter cattle in southeastern Nigeria. *Ann. N. Y. Acad. Sci.*, **1081**:339-346.
- Over H.J., Jansen J. and van Olm, P.W. (1992): Distribution and Impact of Helminth Diseases of Livestock in Developing Countries. FAO Animal Production and Health Paper 96, Rome.
- Pagot J. (1992): Animal Production in the Tropics and Subtropics. MacMillan Education Limited, London.
- Parija S.C. (2004): Hydatid fluid as a clinical specimen for the aetiological diagnosis of a suspected hydatid cyst. *J. Parasit. Dis*, **28**:64-68.
- Parija S.C. (2004): Textbook Medical Parasitology. Protozoology and Helminthology. 2nd Ed. India Publishers and Distributors, India, New Delhi.
- Pawlowski Z. and Murrell K.D. (2001): Taeniosis and cysticercosis. In: Hui Y.H., Sattar S.A., Murrell K.D., Nip W.K. and Stanfield P.S (Eds). Foodborne Disease Handbook. 2nd Ed. New York, Marcel Dekker, Pp. 217-227.

- Pawlowski Z. and Schultz M.G. (1972): Taeniasis and cysticercosis, *Taenia saginata*. *Adv. Parasitol*, **10**:59-343.
- Petrovic A.P. (1976): Prilog poznavanju opsega pojave i rasprostranjenosti *Cysticercosis bovis* u Tanzaniji (On the incidence of Cysricercus bouis in Tanzania). *Vet. Glasnik*, **30**:709-713.
- Pugh K.E. and Chambers P.G. (1989): Observation on *Cysticercus bovis* in slaughter cattle in the Matcheleland province of Zimbabwe. *Vet. Rec*, **125**:480-484.
- Radfar M.H. and Iranyar N. (2004): Biochemical profiles of hydatid cyst fluids of *Echinococcus granulosus* of human and animal origin in Iran. *Vet. Arhiv*, **74**:435-442.
- Radostits O.M., Blood D.C. and Gay C.C. (1994): *Veterinary Medicine*, 8th ed. Balliere-Tindal, London.
- Regassa A., Abunna F., Mulugeta A. and Megersa B. (2009): Major metacestodes in cattle slaughtered at Wolaita Soddo Municipal abattoir, Southern Ethiopia: Prevalence, cyst viability, organ distribution and socioeconomic implications. *Trop. Anim. Health Prod*, **41**:1495-1502.
- Reinecke R.K. (1989): *Veterinary Helminthology*. Butterworths, Durban, Pp. 319-320.
- Roman T. (1987): Study on economic significance of bovine fascioosis and hydsatidosis at Gondar abattoirs. DVM Thesis. Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia.
- Romig T., Omer R.A., Zeyhle, E. *et al.* (2011): Echinococcosis in sub-Saharan Africa: emerging complexity. *Vet. Parasitol*, **181**:43-47.
- Ruiz A. (1997): Prevalence and control of taeniosis and cysticercosis: A global perspective. In: *Cysticercosis*. Report on a workshop held at the Onderstepoort Veterinary Institute, South Africa, 18-19 August 1997. Onderstepoort Veterinary Institute, Onderstepoort (RSA), Pp. 3-18.
- Salih M., Degefu H. and Yohannes M. (2011): Infection Rates, Cyst Fertility and Larval Viability of Hydatid Disease in Camels (*Camelus dromedarius*) from Borena, Kereyu and Harar Areas of Ethiopia. *Global Veterinaria*, **7**:518-522.
- Sariozkan S. and Yalcin C. (2009): Estimating the production losses due to cystic echinococcosis in ruminants in Turkey. *Veterinary Parasitology*, **163**:330-334.

- Schantz P.M., Wilkins P.P. and Tsang V.C.W. (1998): Immigrants, imaging and immunoblots: the emergence of neurocysticercosis as a significant public health problem. In: Scheld, W.M., Craig, W.A. and Hughes, J.M. (Eds). *Emerging Infections 2*. Washington, DC, ASM Press, Pp. 213-42.
- Seimenis A. (2003): Overview of the epidemiological situation of echinococcosis in the Mediterranean region. *Acta Topica*, **85**:191-195.
- Smith J.D. (1994): *Introduction to Animal Parasitology*. 3rd Ed. Cambridge University press, London, UK, Pp. 334-340.
- Soulsby E.J.L. (1982): *Helminthes, arthropods and protozoa of domesticated animals*, 7th ed., pp. 119 – 127.
- Soulsby E.J.L. (1986): *Helminth, Arthropods and Protozoa of domesticated animals*. 7th Ed. BailliereTindall, London, Pp. 119-124.
- StataCorp. (2009): *Stata: Release 11. Statistical Software*. College Station, TX: StataCorp LP.
- Swai E.S. and Schoonman L. (2012): A survey of zoonotic diseases in trade cattle slaughtered at Tanga city abattoir: a cause of public health concern. *Asian Pacific Journal of Tropical Biomedicine*, 55-60.
- Tamene M. (1980): Prevalence study of Echinococcosis in Livestock in Gondar. DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit Ethiopia.
- Taresa G., Melaku A., Bogale B. and Chanie M. (2011): Cyst viability, body site distribution and public health significance of bovine cysticercosis at Jimma, south west Ethiopia. *Global Veterinaria*, **7**:164-168.
- Teka G. (1997): *Food Hygiene Principles and Food Borne Disease Control with Special reference to Ethiopia*. 1st Ed. Faculty of Medicine, Department of Community Health, Addis Ababa University, Pp. 40-62.
- Tembo A. (2001): *Epidemiology of T. saginata taeniasis and cysticercosis in three selected agro climatic zones in central Ethiopia*. Faculty of Veterinary Medicine Addis Ababa University, Free University of Berlin, Unpublished MSc thesis.
- Terefe A., Shimelis T., Mengistu M., Hailu A. and Erko B. (2011): *Schistosomiasis mansoni* and soil-transmitted helminthiasis in Bushulo village, southern Ethiopia. *Ethiop. J. Health Dev*, **25**:46-50.

- Tesfaye D., Sadado T. and Demissie T. (2012): Public Health and Economic Significance of Bovine Cysticercosis in Wolaita Soddo, Southern Ethiopia. *Global Veterinaria*, **9**:557-563.
- Thompson R.C.A. and Eckert J. (1983): Observations on *Echinococcus multilocularis* in the definitive host. *Z parasitenkd*, **69**:335-345.
- Thompson R.C.A. and Kumaratilake L.M. (1985): Comparative development of *Echinococcus granulosus* in dingoes (*Canis familiaris dingo*) and domestic dogs (*Canis familiaris familiaris*) with further evidence for the origin of the Australian sylvatic strain. *International Journal for Parasitology*, **15**:535-542.
- Thompson R.C.A., Kumaratilake L.M. and Eckert J. (1984): Observations on *Echinococcus granulosus* of cattle origin in Switzerland. *Int. J. Parasitol*, **14**:283-291.
- Thrusfield M. (2005): Veterinary epidemiology. 3rd Ed. Blackwell Science limited, Oxford, UK, Pp. 228-246.
- Tolosa T., Tigre W., Teka G. and Dorny P. (2009): Prevalence of bovine cysticercosis and hydatidosis in Jimma municipal abattoir, South West Ethiopia. *Onderstepoort Journal of Veterinary Research*, **76**:323-326.
- Umur S. (2003): Prevalence and Economic Importance of Cystic Echinococcosis in Slaughtered Ruminants in Burdur, Turkey. *J. Vet. Med. B*, **50**:247-252.
- Unger F., Münstermann S., Carayol D., Marcotty T. and Geerts S. (2008): Bovine Cysticercosis in The Gambia. *Revue Élev. Méd. Vét. Pays Trop*, **61**:15-17.
- Urquhart G.M., Duncan J., Armour L., Dunn J. and Jennings A.M. (1996): Veterinary parasitology. 2nd Ed. Blackwell Science, Oxford, Pp. 120-129.
- Van Knapen F. and Buys J. (1985): Lintwormen in Nederland. *Ned. Tijdschr. Diergeneesk*, **110**:761-770.
- Walther, M. and Koske, J.K. (1980): *T. saginata* cysticercosis: a comparison of routine meat inspection and carcass dissection results in calves. *Vet. Rec*, **106**:401-402.
- Wanzala W., Kyule N.M., Zessin K.H., Onyango-Abuje A.J., Kangethe K.E., Ochanda H. and Harrison J.S.L. (2006): Evaluation of an antigen-ELISA in the diagnosis of bovine cysticercosis in Kenyan cattle. *Parasitol Res*, **100**:539-548.

- Wanzala W., Onyango J.A., Kangethe E.K., Zessin K.H., Kyule N.M., Baumann M.P., Ochanda H. and Harrison L.J. (2003a): Control of *Taenia saginata* by postmortem examination of carcasses. *African Health Sci*, **3**:68-76.
- Wanzala W., Onyango-Abuje J.A., Kangethe E.K., Zessin K.H., Kyule N.M., Baumann M.P.O., Ochanda H. and Harrison L.J.S. (2003b): Analysis of post-mortem diagnosis of bovine cysticercosis in Kenyan cattle. *Online Veterinary Research*, **1**:28-31.
- Wayne L. John N. Dave B. and Brad S. (2002): Outbreak of *C. bovis* (*T. saginata*) in feedlot cattle in Alberta. *Canadian Veterinary Journal*, **43**:227-228.
- Wen H., New R.R.C. and Craig P.S. (1993): Diagnosis and treatment of human hydatidosis. *Br. J. Clin. Pharmacol*, **35**:565-574.
- WHO (1983): Guidelines for Surveillance, Prevention and Control of Taeniasis/Cysticercosis. In: Gemmell M, Matyas Z, Pawlowski Z, Soulsby. World Health Organization (WHO).
- WHO/OIE (2002): Manual on Echinococcosis in humans and animals. In: Eckert, J., Gemmell, M.A., Meslin, F.X. and pawlowski, Z.S. (Eds). A public health problem of Global concern. Paris, France.
- Yamasaki H., Allan J.C., Sato M.O., Nakao M., Sako Y., Nakaya K., *et al.* (2004): DNA differential diagnosis of taeniasis and cysticercosis by multiplex PCR. *J. Clin. Microbiol*, **42**:548-553.
- Yildiz K. and Gurcan S. (2003): Prevalence of hydatidosis and fertility of hydatid cysts in sheep in Kirikkale, Turkey. *Acta Veterinaria Hungarica*, **51**:181-187.
- Yilma J. (1985): Preliminary study on Echinococcosis/Hydatidosis in ruminant slaughtered at Nazerath Abattoir. DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit Ethiopia.
- Zewdu E., Teshome Y. and Makwoya, A. (2010): Bovine Hydatidosis in Ambo Municipality Abattoir, West Shoa. *Ethiopia. Ethiop. Vet. J*, **14**:1-14.
- Zimmerman G. (1985): Kritische Betrachtung zur Verbreitung der Zystizerkose beim Rind und Vorschläge zu verbesserten Bekämpfungsmassnahmen der Rinder-bandwurm-Invasion beim Menschen. *Tierarztl. Umschau*, **4**:257-264.

7. APPENDIX

Appendix 1: A Questionnaire presented to people residing in Addis Ababa city for *Taenia saginata* taeniosis survey.

Region _____ Zone _____

District _____ Date _____

Village _____ Code _____

Address _____

Respondent's age categories 0-15, ___ 16-20, ___ 21-25, 26-30, ___ 31-40, _____ above _____

1. Sex: Female _____ Male _____

2. Religion: Christian _____ Muslim _____ Other _____

3. Occupation _____

4. Your level of education: Nonformal _____ Formal _____

5. In what form do you eat cattle meat (beef) a) raw _____ b) Cooked _____

6. Have you ever suffered from taeniosis with in the pat one year? Yes _____ No _____

7. Have you observed any symptoms of illness whenever you get infected with tapeworms?

Yes _____ No _____

8. If yes for question 7, above which one (s) of the following symptoms did you notice?

Diarrhea _____ Hunger Pain _____ Constipation _____

Epigastric Pain _____ Weakness _____ Increased appetite _____

Decreased appetite _____ Dizziness _____ Headache _____

Loss of weight _____

9. Disturbance by crawling T. Saginata _____

10. How many people in your household have suffered from tapeworm infec?

11. Which of the following taenicial drugs have you used in the past to treat yourself?
Modern drugs available in pharmacies?

Vermox (Mebendazole) _____ Kosso farm (niclosamide) _____ Diclorophen _____
Praziquantel _____ other specify _____

12. Which traditional taenicial drugs commonly used in Ethiopia?

“Kosso” _____ “Enkoko” _____ “Meterie” _____ “Duba Fire” _____
Other specify _____

13. How often did you take taenicial drugs? _____

14. Where do you get the taenicial drugs?

Pharmacy _____ Herbalist _____ Home preparation _____

15. How many times in your lifetime have you taken that tapeworm treatment?

Modern _____ Traditional _____

16. How much does a single dose of tapeworm treatment cost you?

Modern _____ Traditional _____

17. Which drugs do you think are more effective to that of the tapeworm infection?

From the traditional drugs	From the modern drugs
_____	_____
_____	_____
_____	_____
_____	_____

18. Have you ever had ill-health complications upon taking those treatments?

Yes _____ No _____

If yes,

	Only once	Rarely	commonly
Modern drug	_____	_____	_____
Traditional Drugs	_____	_____	_____
Both	_____	_____	_____

19. If yes to question 21, could you please state the major symptoms of complication you have observed? _____.

20. Have you ever heard of serious complications (death) from taking taenicial drugs?

Yes _____ No _____

21. Do you know the cause of tapeworm infections? Yes _____ No _____
22. In your opinion, which food of animal species serves as a source of human tapeworm infection?
Cattle _____ sheep _____ goat _____ camel _____ poultry _____ fish _____
23. Do you recognize tapeworm infection from the meat? Yes _____ No _____
24. How do animals get the cyst? _____.
25. In the identified animal above question 25, which organs, or tissue or parts of the flesh do you think contain the infective form of the parasite?
_____.
26. Do you believe that butchers inform their customers on whether the meat is infected or not? Yes _____ No _____
27. Do you think tapeworm infection/teaniosis can be prevented? Yes _____ No _____
28. If yes, state how it could be achieved? _____
29. Do you use spice? Yes _____ No _____

Appendix 2: Consequences of *Taenia saginata* taeniosis in man and animals in short.

Man	-Adult tapeworm in the intestinal tract (taeniosis) shedding of proglottide and/ or eggs with the faeces.
1. <i>T. saginata</i> and <i>T. solium</i>	-Only mild clinical symptom
2. <i>T. solium</i> only	-Cysticercosis in organs, subcutaneous tissues. The larval stage of the tapeworm (<i>Cysticercus</i>) is embedded in muscles, liver/lung, or directly under the skin. -Depending on the number and localization of cysticerci moderate to severe symptoms. -Neurocysticercosis. -The larval stage of the tapeworm is embedded in brains and/ or eye. -Severe clinical symptoms
3. Cattle (<i>T. saginata</i>)	-Cysticercosis in muscle -The larval stage of the tapeworm (<i>Cysticercus</i>) is embedded in musculature of cattle through the body. -No clinical symptoms, however abattoir diagnosis is made by (the rather).
4. Pigs (<i>T. solium</i>)	-Cysticercosis in muscles and subcutaneous tissues, sometimes in liver lungs and brain. -No clinical symptoms, however abattoir diagnosis is based on visual inspection of the carcasse only.

Source: WHO/OIE (2002)

Appendix 4: Description of body condition score

Scores	Condition	Features
1	P ⁻	Marked emaciation (animal could be condemned at ante mortem examination)
2	P	Transverse process project prominently, neural spines appear sharply.
3	P ⁺	Individual dorsal spines are pointed to the touch, hips, pins, tail head and ribs are prominent. Transverse process visible, usually individually.
4	M ⁻	Ribs, hips and spines clearly visible muscle mass between hook of spines slightly concave and slightly more flesh above the transverse process
5	M	Ribs usually visible little fat cover dorsal spines barely visible.
6	M ⁺	All smooth and well covered, dorsal spine cannot be seen, but are easily felt.
7	G ⁻	All smooth and well covered, but fat deposits are not marked, dorsal spines can be felt with firm pressure but rounded rather than Sharpe
8	G	Fat cover in critical areas can be easily seen and felt, transverse process cannot be seen
9	G ⁺	Heavy deposit of fat clearly visible on tail, head, brisket and cad, dorsal spine , ribs, hook and spines fully covered and cannot be felt even with firm pressure

Source: Nicholson and Butterworth (1986).

Note: body condition scores

- 1, 2, and 3 are poor body condition
- 4, 5, and 6 are medium body condition
- 7, 8 and 9 are good body condition

Appendix 5: Age determination in cattle based on their teeth

Age/year	Characteristic change
1-month	The entire set of eight temporary incisors appear in the calf
2-years	The first two central incisors are replaced with permanent teeth
3-years	The first intermediates (one of each side of the pincers) are fully developed
4-years	The second set of intermediates are present
5-years	The animals usually has a full set of incisors with the corners fully developed

Note. Wearing of the teeth starts to become quite noticeable by the age of five .Considerable wear is found at seven to ten years of age. By age twelve the arch in the animal's mouth has disappeared and the teeth become triangular.

Source: Ensminger (1992).

Appendix 6: Curriculum Vitae

I. Bio Data

Name	Bayissa Tesfaye Gebre Mariam
Nationality	Ethiopian
Date of Birth	1960 G.C
Sex	Male
Place of Birth	Jimma Geneti, Wollega
Marital Status	unmarried
Religion	Orthodox
Driving License	3 rd Grade
Adress	Tel:- 0114-34-22-79 Residence

+251-911-38-54-62

II. Educational Background

Year	Place	Academic Award
1986 G.C	Latin America	Doctor in veterinary Medicine
1977 G.C	Jimma Agri College	Diploma in General Agriculture
1972 G.C	Secondary high school	School Leaving Certificate

III. Language

	Speaking	Reading	Writing
Amharic	Excellent	Excellent	Excellent
Oromiffa	Excellent	Excellent	Excellent
English	Excellent	Excellent	Excellent
Spanish	Excellent	Excellent	Excellent

IV. Work Experience

- 2002 to date senior animal health expert in pastoral and agro- pastoral extension areas, Animal Health Curriculum Development and Supervision programme (MOARD).

Tasks and Responsibilities

- Identify major animal diseases in pastoral & agro- pastoral extension areas.
- Set up regular animal treatment and vaccination programme in all extension areas.
- Conduct training for selected target groups.
- Arrange training of trainers for animal Health care workers and others staffs.
- Close supervision the under going animal health day to day works.
- Random collection of blood and other samples for further animal diseases investigation.
- Fellow- up regular supply of animal Health Medicine and equipments to the areas.
- Establish mini clinic and Laboratories in the extension areas.
- Establish pasture and forage development in selected areas.
- Establish water drinking traffs in different areas.
- Develop Animal Health curriculum.
- Review the curriculum and disseminate to all ATV college
- Prepare academic rules regulation for all ATV college
- Evaluate and supervise periodically teaching and Learning Process under way in all ATV colleges.
- Prepare manuals and Hand-outs in all animal health courses under way.
- Conducts and facilitate training of trainers in Animal Health

2. 1994- 2001 instructor, vice Dean and Dean, at former Ardaita Yekatit 25 cooperative institute, now Ardaita Agricultural Technology Vocational and Educational Training College.

Tasks and Responsibilities:-

- Administer the undergoing activities of the college
- Manage and control day to day activities of the college
- Prepare Animal budget of the college
- Set-up Tentative academic programme of the college
- Participate in course breakdown and arrangement of lesson plan.
- Fully participate in teaching and learning process
- Arrange periodically meeting with the staffs.
- Follow-up daily utilization of financial system of the college

- Set-up regular supervision and controlling system in all departments of the college.
 - Arrange further Training for all staffs
 - Set-up programme visiting departments, students Dormitories, Dining room, class rooms etc.
 - Establish a good working atmosphere among different teams.
 - Establish a good governance in the college
 - Establish a good working relationship and share experience with different colleges and universities.
 - At the end of the fiscal year arrange inventory programme.
 - Follow-up properly utilization of different properties and Vehicles of the college.
3. 1987—1993 G.C general Manager, cattle Breeding and multiplication ranch (MOARD)

Tasks and Responsibilities

- Administer the underway activities of the Breeding farm.
- Manage and control day to day activities going in the Breeding farm
- Arrange regular meeting with the staffs.
- Participate in treatment and vaccination programme.
- Set-up Breeding and insemination Tentative Programme.
- Establish pasture and forage dev't on the farm areas
- Follow- up proper utilization of materials and financial system.
- Arrange on job training for all staffs.
- Set-up programme to take blood and other samples.
- Make sure there is enough medicine & equipments.
- Establish animal health mini clinic & laboratory.
- Establish quartile and isolation places for sick animals on the farm.
- Make sure all animals on the farm have identification number & ear tags
- Close supervision of materials and vehicles of the Breeding farm.

Reference

- Dr. Edimealem Shitaye D.V.M PHD Mobile 0913-16-59-21
Pastoral & agro pastoral extension senior expert (MOARD)

- Dr. Tomas Chernet DVM, MSC, PHD Mobile:- 0911-46-18-29
Sebeta national Laboratory- Senior Researcher
- Dr. Muluneh Tessema DVM. MSC Mobile 0911-01-88-76