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ADDIS ABABA UNIVERSITY
FACULTY OF VETERINARY MEDICINE

STUDY ON THE PREVALENCE OF BOVINE CYSTICERCOSIS IN AWASSA MUNICIPAL ABATTOIR AND *TAENIA SAGINATA* IN AWASSA TOWN AND ITS SURROUNDINGS, SOUTHERN ETHIOPIA

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A thesis submitted to the faculty of Veterinary Medicine, Addis Ababa University in partial fulfillments of the requirements for the Degree of Master of Science in Tropical Veterinary Epidemiology

By

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

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LIST OF ABBREVIATIONS

AAU	Addis Ababa University
a_w	Water activity
CAA	City Administration of Awassa
CDC	Center for Disease Control
CI	Confidence interval
CNS	Central Nervous System
CSA	Central Statistical Authority
CTA	Technical Center for Agriculture and rural cooperation
df	degree of freedom
DNA	Deoxyribonucleic Acid
DVM	Doctor of veterinary medicine
EC	European commission
ELISA	Enzyme Linked Immunosorbent Assay
FVM	Faculty of Veterinary Medicine
IHAT	Indirect Haemagglutination Test
K rad	Kilo radiation
kg	kilogram
Kms	kilometers
masl	Meter above sea level
mg	milligram
MSc	Master of Science
^oC	Degree centigrade
OIE	Office Internationale des Épizootics
OR	Odds Ratio
PCR	Polymerase Chain Reaction
PHARMID	Pharmaceuticals and Medical Supplies Importer and Distributor
SZPEDD	Sidama Zone Planning and Economic Development Department
WHO	World Health Organization

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ABSTRACT

The study was made from October 2005 to April 2006 at the Southern Nation, Nationalities and Peoples Region, Awassa town and its surroundings. It was carried out with the overall objective of providing base line data on the prevalence of *C. bovis*/*T. saginata*. A total of 400 carcasses of randomly selected bovine animals were used for the active abattoir survey. The study comprised of an active abattoir survey data collection at Awassa municipal abattoir, questionnaire survey on volunteer respondents and an inventory of pharmaceutical drug stores and shops in Awassa town. Of the 400 carcasses examined during the study period, 105 (26.25%) were infected with *C. bovis*. The distribution of organs/tissues infected with *C. bovis* were, heart (11.25%), diaphragm (1.75%), masseter (8.5%), kidney (0.25%), lung (0.5%), shoulder (9%), tongue (3.25%), and liver (0.75%). Analysis of active abattoir survey revealed that there was a significant difference ($P < 0.05$, OR = 3.34) between breeds, but there were no significant differences observed in the infection rates between sex ($P > 0.05$, $\chi^2 = 0.02$) and origin ($P > 0.05$, OR = 0.87) of the animals. The viability test on all isolated bladder worms showed that 44.2% were viable. The tongue, heart, shoulder and masseter muscles had the highest number of viable (11.25%), (9%), (8.5%) cysts respectively. Based on the questionnaire survey, *T. saginata* taeniosis is a wide spread problem in Awassa town and its surroundings. 64.2 % of the respondents had contracted taeniosis due to *T. saginata*. The potential risk factors of taeniosis namely, age, sex, religion, occupation, educational levels, raw meet consumption, use of spices during meat consumption and marital status were considered. The prevalence of taeniosis was slightly significant by the age of the respondents ($P<0.05$ and $\chi^2=6.23$). There was no association between the prevalence of taeniosis and sex ($P> 0.05$ and $\chi^2 = 0.44$). Among Muslim and Christian communities, it was found that there was a statistical significant difference in the prevalence of taeniosis ($P<0.05$ and OR = 5.34), higher in the Christian communities. Statistical analysis indicated that there was a significant difference between occupation between low and high-risk groups ($P<0.001$ and $\chi^2 = 15.79$). Educational backgrounds had no significant association with the prevalence of taeniosis ($P>0.05$ and OR = 0.71). The prevalence of taeniosis was highly significant ($P<0.001$ and OR = 8.47) in the raw meat eaters as compared to those consuming cooked meat. The use of spices

during meat consumption was analyzed and found to be significant in those who had the habit of using spices with meat (P<0.001 and OR =12.03). Marital status had also significant effect on the prevalence of taeniosis among the respondents (P<0.05 and χ^2= 7.00), higher in married ones. In addition; multivariate analysis (logistic regression) showed that raw meat consumption, occupation and use of spices with meat were important risk factors for taeniosis. Statistical analysis showed that preferences of the available taenicidal drugs among the respondents were Niclosamide (62.5%), Mebendazole (56.67%), Albendazole (53.33%) and Praziquantel (48.33%). The annual taenicidal drug treatment cost in the study area from 2002-2005 by prescription and complaints of patients was estimated to be 7, 219,019.95 Eth. Birr. The drug inventory clearly demonstrated the economic significance of *T. saginata* taeniosis in the study area. According to the respondents, the use of traditional herbal taenicidal drugs was not commonly practiced. But it is well understood that a considerable proportion of residents mainly use herbal drugs due to its highly purgative effect and cheaper price. Hence, this disease deserves serious attention by the various stakeholders in order to safeguard the health of the residents of Awassa town, consumer and further promote beef industry in the study area in particular and the country in general. The distribution of *T. saginata* cysts in carcasses, the potential risk factors for taeniosis and the economic impact of this parasite are also discussed.

Key Words: Prevalence, *C. bovis*, *T. saginata*, risk factors, Awassa, Southern 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 /*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 *C. bovis* (Pawlowsk, 2001; Gracey and Collins, 1992.).

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 (Fralova, 1985), since it is shown that the egg can survive in sewage (Arundel 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 there 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.*, 2003).

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 is 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 *Tania 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 in the southern part of Ethiopia makes this study necessary to identify gaps between weather 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
- To examine the situation of taeniosis based on the questionnaire
- To estimate the economic impact of the disease through inventories of pharmaceutical shops
- To recommend appropriate control measures

2. LITERATURE REVIEW

2.1. Taxonomic classification

The unarmed meat tapeworm of human; *T. saginata*, and its metacestode, *C. bovis* belong to the class of cestoda, order cyclophyllidea, family Taeniidae and genus Taenia (Urquhart *et al.*, 1996).

2.2. Morphology

2.2.1. Adult worm

T. saginata is ribbon-shaped, flattened, multisegemented and hermaphrodite. The body is divided into three distinct parts of scolex (head), neck and strobila. *T. saginata* measures 4-8 meters in length and rarely measures up to 15m (Urquhart *et al.*, 1996). Anteriorly, the scolex (head) has four muscular suckers often unarmed, no 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. 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 and OIE, 2004). The neck is short unsegemented 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 sheded 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 5 mm 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).

2.2.2. Egg

Taenid eggs passed in the faeces or discharged from ruptured gravid segments are sub spherical 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 eggshell, which is voided in 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 oncospheral membranes .The mature ova are present only in the terminal 30-50 proglottids, and some immature ova can mature out side the host within about 2 weeks, where as 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).

2.2.3. Larvae

Over a period of 3-4 months, the cysticerci are formed 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). *C. bovis* is a small (pea sized) oval in shape (OIE, 2001). *C. bovis* is grayish white, about 1cm 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 and Smyth, 1994).

2.3. 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 and 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 abomasum, it will be attacked by pancreatic secretion on reaching the duodenum and it disintegrates releasing the oncosphere (Smyth, 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 work their way into muscle tissue, including that of the heart and other organs (Figure, 1). The irritated tissue reacts by forming cysts around the invaders. Fortunately, cattle cannot transmit the disease 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 feces or by migration through the anus.

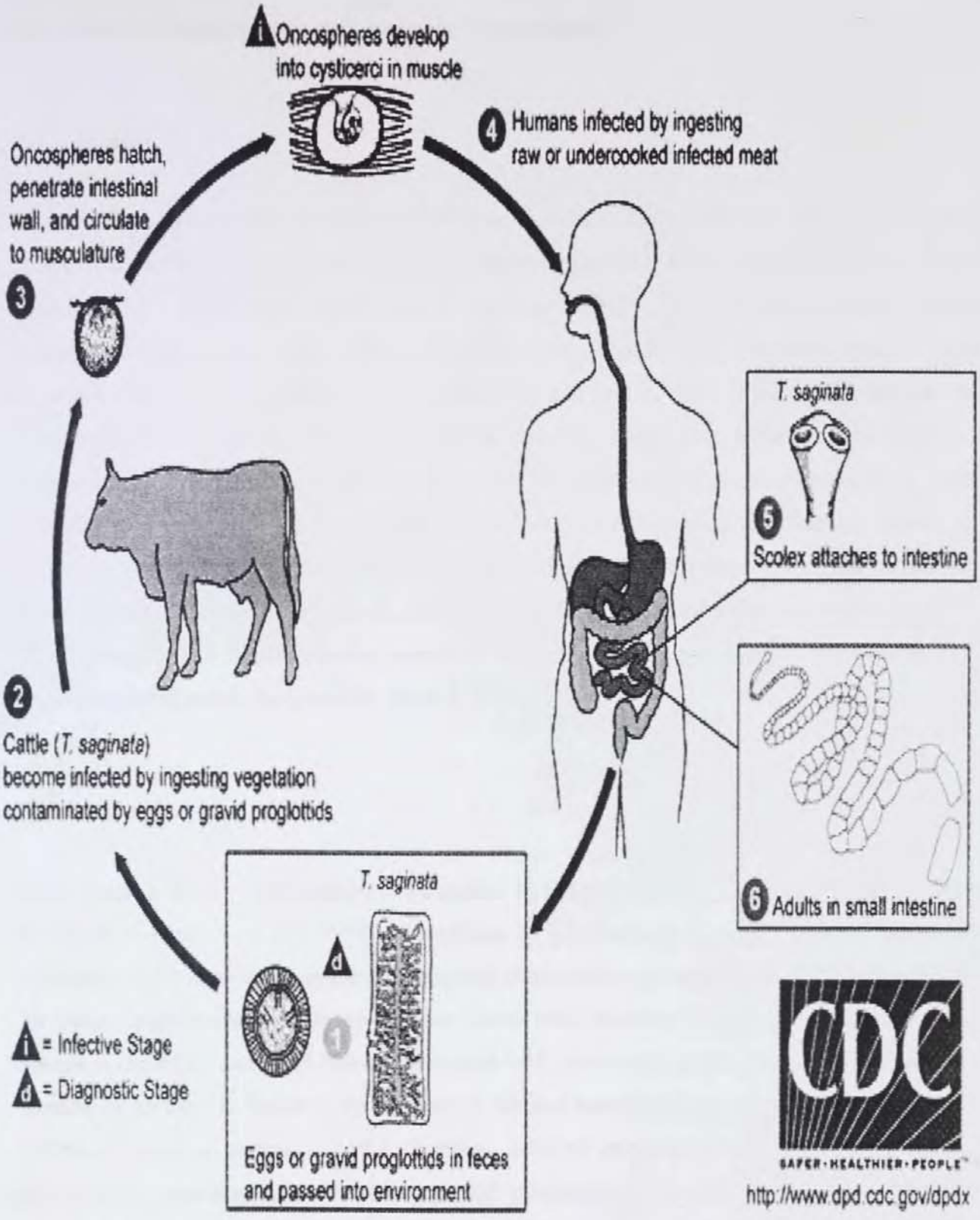

Figure 1: Life cycle of *T. saginata*/*C. bovis*, (CDC).

2.4. Clinical manifestations of *T. saginata* / cysticercosis

2.4.1. Human

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, weight loss, increased appetite and itchiness. Tapeworm segments may appear in their stool. The infection in human is asymptomatic although 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). *T. saginata,* like all other human helminthes, may induce variable symptoms or may cause an unrecognized infection. However an 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).

2.4. 2. Animals

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 no 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).

2.5. Diagnosis

Adult cestodes can be expelled from human using an antehelmithics 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, fecal 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, *at al.*, 1999; Biru, 1983). 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 weather 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 features on daily basis; 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 DNA from the sample (Nunes *et al.*, 2003).

Live cattle show no 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, 2004).

2.6. Differential diagnosis

It is difficult to differentiate *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 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 mesocetode of the hyaenae which is twice as long as *C. bovis* measuring 12 to 18mm in length, pearly white in color and possess double row of hooks on the lateral part of scolex. Hailu (2005) and Amsalu (1989) have reported this cyst in this country. The diagnosis of *O. 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 some times in other muscle. *O. dukei* measures 3 to 6 mm in diameter which form intra-muscular and sub-cutaneous 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 warm remains in the gut even after treatment hence this is not always available for differentiation. A

much-used criterion is the number of lateral branches 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 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 hooks; 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, *Taenia 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.*, 1990). 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 deferential identification of *Taenia asiatica* and *Taenia 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*.

Table 1: The characteristic features for the differentiation of *T. saginata, T. solium* and *T. asiatica*, (Eom, and Rim, 1993*and Smyth, 1994).

Characteristics	*T. saginata*	*T. asiatica**	*T. solium*
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 lobs	2 lobs	3 lobs
Vaginal sphincter	Present	Present	Absent
Egg size	40 × 50 micro meter	33 × 28 micro meter	40 × 50 micro meter
Cysticercus size	10mm × 6mm	1320 × 3129 micrometer	20×10mm
Gravid proglottids			
Uterine branches	23(14-32)	17(12-26)	8(7-11)
Passing of proglottids	Spontaneous, singly	Spontaneous, singly	Passively in groups

*it has wart like formations on the larval bladder surface, posterior protuberance in the gravid proglottids and the large number of uterine twigs

2.7. Treatment

For the treatment of the taeniosis there are a number of taenicidal drugs available in the market. However, the drugs of choice in treating taeniosis are Niclosamide (Niclosamide, Yomesan).

Adult dose rate of 2000mg 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 carbamate class, which is effective against larval and adult stages of cestodes and trematode (Yasmine *et al.*, 1999). Single dose of Praziquantel i.e., (15 mg/kg) efficacies in diphyllobothriasis, taeniarhynchiasis, and taeniosis made up 91.4, 98.5, and 100%, respectively (Bronshtein *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 yr 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).

In Ethiopia, the majority of the rural inhabitants use traditional herbal drugs in routine self-deworming. As a result a number of traditional herbal drugs are used as a taenicidal drugs (Table, 2). Comparative study on the efficacy of some of the taenicidal herbs has been topic for researchers in Ethiopia (Berhanu and Ermias, 1978 and Desta, 1995).

Table 2: Major Taenicidal herbs used in Ethiopia arranged in decreasing order of potency (Berhanu and Ermias, 1978, Desta, 1995 and Feseha, 1995*).

Local name	Scientific name	Parts used
Bisana	*Croton macrosatchuys*	Bark*
"	"	Seeds
Enkoko	*Embelia schimperi*	Fruits*
Duba fire	*Cucurbita pepo*	Seeds*
Tosigne	*Thymus serrulatus*	Dn#
Kosso	*Hagenica abyssinica*	Flowers*
Kechema	*Myrsine africana*	Dn#
Keleum	*Maesa lanceolta*	Dn#
Serdo	*Cynadon dactylon*	Dn#
Dendera	*Echinaps gignantean*	Dn#
Metterie	*Glinus lattoides*	Dn#
Gorrteb	*Plantago lancceolata*	Dn#

Dn# =Do not know

2.8. Control strategies for cysticercosis

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, 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 (thoroughly cook or freeze) all meat before it is eaten to prevent consumption of live tapeworm larvae in infected samples (Table, 3). Larval cysts in meat are killed by moderate temperatures of 150°F (65°C) or if frozen for at least 12 hours (Gracey *et al.*, (1999).

Cheruiyot and 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. Co-operation between medical and veterinary services is considered important (Cheruiyot and Onyango-Abuje, 1984). Meat inspection is also important. The effectiveness of many inspection regimes may be poor. Ogurinade 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 studied 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, 1995 and Ogurinade and Oyekele, 1990). Meat which not inspected is often consumed in rural areas at the time of marriages and other festivals (Cheruiyot and Onyango-Abuje, 1984).

Maeda (1995) 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 (Maeda, 1995). 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 philippinensis 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 helmintic 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, 2000) 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, 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 (EC, 2000).

Process	Characteristics	Effect on cyst
	<-5 °C for 360 hours	Death of the cyst
Freezing	<-10 °C for >216 hours	Death of the cyst
	<-15 °C for >144 hours	Death of the cyst
Heating	>56 °C core temperature for > 1 second	Death of cysts
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 o cyst

2.9. Prevalence and economic impact of taeniosis

2.9.1. Prevalence

T 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 into 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 Republics of Union 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, Australia and New Zealand (Urqhuart *et al.*, 1996).

The situation of this disease in Africa is quite common, reaching 3.2-7.5% in Nigeria (Okolo, 1986 and Fertig, 1985), 12.5% in Botswana (Mosienyane, 1986) greater than 10% in Sudan (Fralova, 1985), 30-36% 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 parents 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% in 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* (Onyango-Abuje *et al.*, 1996). The high prevalence was caused by the management practices of pastoralists such as in Narok 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).

1.9% of cattle were infected with *C. bovis* and 1.0% of sheep and 0.8% of goats infected with *C. ovis* (Dada, 1978). 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– 9 %), 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). *C. 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 humans in Ethiopia, Kenya and Democratic Republic of Congo (formerly Zaire) are reported to have *T. saginata*. Antia and Alonge (1982) report that in Southern 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 humans had Taenia (Ruiz, 1997). The disease has also been reported in China, Korea, Indonesia and The Philippines and is also possibly present in Thailand. *T. saginata* has been reported in China, India, and Cambodia and is highly prevalent in Laos.

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 fecal 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, 1989). The incidence of *C. bovis* in carcasses of cattle originating from communal areas was 3.2 per cent compared with 1.6 per cent 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 used 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: Prevalence of bovine cysticercosis and incidence of human taeniosis in various European countries, (EC, 2000).

Country	Cysticercosis*(%)	Taeniosis** (%)	Reference
Denmark	0.1-0.7	0.02	Ilose (1990)
Germany			
former east	4.5-6.8	0.33-0.62	Mobius (1993)
former west	0.4-0.8	0.09	Zimmerman (1985)
Netherlands	1.8-2.2	0.14	Knapen, (1985)
Belgium	0.03-0.2	0.26-0.46	Geerts (1992)
Poland	0.24	1.64	EC (2000)
Italy	0.02-2.4	0.02-0.04	EC (2000)

*prevalence based on the abattoir data

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

2.9.2. 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 Kenya it is bout 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).

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 freezing, boiling) or condemned, as well as the costs involved in the inspection procedures amount to millions of dollars (Nunnes, 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 humans and cattle. Thus taeniosis (cysticercosis, 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 work 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 of the economic importance of the drug in each household. The total dose of Niclosamide and Diclorophen production in the drug factories in this country (Table, 5) 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, 6) during the year 2000 (Tembo, 2001).

Table 5: Taenicidal drugs production at the Ethiopian pharmaceutical company for a 5-year period (Tembo, 2001).

Year	Niclosamide Annual dose	Diclorophen Annual dose	Total Annual dose
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	416,833	4,900,833
2000	5,033875	-	5,033,875
Total	25,968,500	5,846,333	31,814,833

Table 6: Inventory of annual taenicidal drugs dose and their worth in central Ethiopia, (Tembo, 2001).

Taenicidal Drugs	Akaki		Debre Zeit		Nazareth		Total	
	Doses	Worth (birr)	Doses	Worth (birr)	Doses	Worth (birr)	Doses	Worth (birr)
Albendazole	553	11446	8825	105691	24526	486039	33904	603176
Diclorophene	12520	19406	3443	5352	2738	4107	18701	28865
Mebendazole	14711	54587	36442	99223	71187	481992	122320	635802
Niclosamide	33219	30783	37720	35446	106882	113211	177821	179460
Praziquantel	553	1490	4278	9592	4078	13436	8909	24518
Total	61556	117712	90688	255324	209411	1098783	361655	1471821

Based on the data collected by Bartaket *et al.* (1982) from fattening houses, economic consequences of cysticercosis in cattle reared on the farm Ceske Velenice (district of Jindrichuv Hradec) 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 8.56 Kcs (Czechoslovak crowns) per one kg of live weight. In that year, financial losses amounted up to

6.93 Kcs per 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 (Bartaket *et al.*, 1982).

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, 7)

Table 7: Economic implication of cysticercosis in cattle (Olteanu *et al.*, 1982)

Morbidity	Diminution of natural resistance of the host's organ	Additional expenses for treatment of animals
Fodder consumption	Economic implications of cysticercosis in cattle	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	

3. MATERIALS AND METHODS

3.1. Study area

The study was conducted from October 2005 up to April 2006 in Awassa town and its surroundings, Southern Nations, Nationalities and Peoples Region. Awassa is the capital city of Sidama Zone and the region, located on the shore of one of the Rift Valley lakes. Awassa is located at 275 kms south of Addis Ababa, 100 kms south of Ziway and 20 kms south of Shashemene. It is 1500-2000 meters above sea level and between 4° 27' and 8°30' latitude North and 34° 21' and 39° 1'East longitude. The total population of Awassa is estimated to be 150,000, covers an area of 50 km^2. The annual rainfall and temperature range of the town is 800-1000mm and 20.1-25^{0}c respectively (CAA, 2004). The total livestock population of Sidama zone is estimated to constitute 1,573,318 cattle, 183,462 goats, 221,505 sheep, 49,150 horses, 48,653 asses, 3,959 mules, 1,196,506 poultry, and 73, 479 beehives (CSA, 2003). As elsewhere in rural Ethiopia, the economic life of the people in Sidama zone is mostly dependent on mixed farming in that 93% of the population is engaged in agriculture. Livestock production occupies an enormous share in farm economy. The high and mid landers are sedentary while transhumance is the style for lowlanders. The most important food crops produced are maize, *enset*, wheat, barely, *teff*, pulses and coffee as an important cash crop (SZPEDD, 2001).

Active abattoir survey was carried out in Awassa municipal abattoir, which is located at 5 km out side of the town and provides inspected meat to the residents of Awassa town. The facilities such as water, electricity, road, hygiene and well-trained personnel are not sufficient; however, the abattoir is constructed on an ideal place. The fence of the compound was not well constructed, as a result dogs, hyena and other carnivore animals were found to be disturbing the meat inspection process. Different age groups of animals were slaughtered in the abattoir and it usually commence at 2: 00 am in the night at each working days except for Tuesday and Wednesday night, since the next day would be fasting. Bleeding was effected by

cutting the jugular vein of the animals after stunning with the sharp knife at the medulodlongata. Bleeding and dressing of carcasses were performed manually in the same room. Two meat inspectors carried out meat inspection. One of the inspectors was trained in Botswana for six months and performing better in meat inspection. There was no tradition in record keeping in this abattoir that is why retrospective abattoir data analysis was no included in this study.

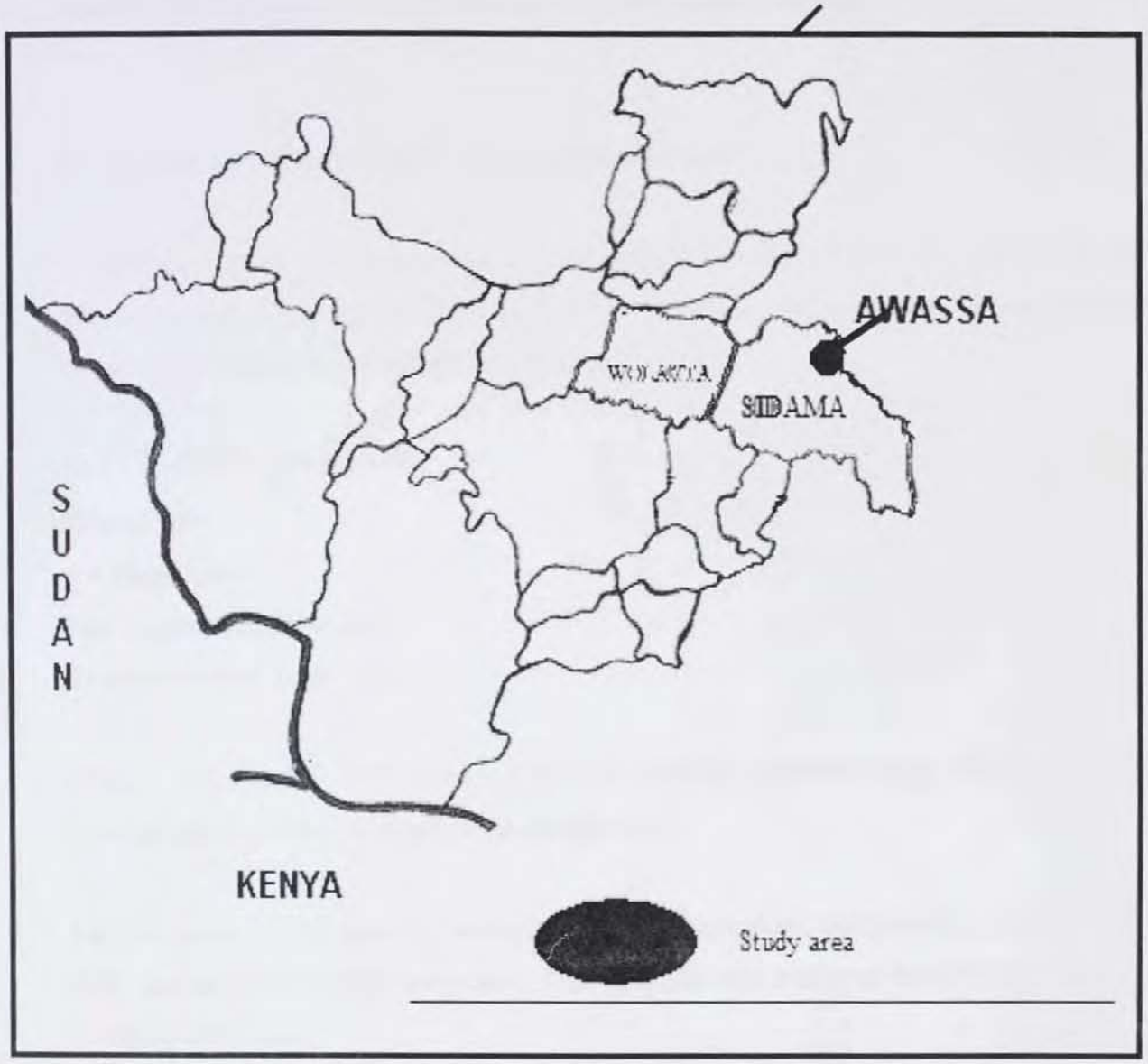

Figure 2: Map of the study area (CAA, 2004)

3.2. Study population

Cattle presented to Awassa municipal abattoir for routine meat inspection were used for the cross sectional survey. For the questionnaire survey, identification of respondents was based on random selection of volunteers from Awassa town and its surrounding peasant associations. In the drug inventory study, relevant information was gathered from pharmacies, rural drug vendors, and hospitals/clinics in Awassa town and its surroundings.

3.3. Sample size determination and sampling method

Since there was no previous survey conducted in the southern part of the country to estimate the prevalence of the disease, the sample size was determined according to Thrusfield (1995) by taking 50% prevalence using the following formula:

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

Where,

n = sample size

P_{exp} = expected prevalence

d =desired absolute precision

If P_{exp} = 50% and d = 0.05, then n = 385. But for this particular study, 400 bovine carcasses were sampled in order to increase the sample size.

For the questionnaire survey, random selection of volunteer individuals who live in Awassa town and its surroundings were used. The selection was based on the different age, sex, and working conditions.

In an inventory of pharmaceutical shops, data from volunteer government and privately owned pharmaceutical shops were recorded.

3.4. Study methodology

3.4.1. Cross-sectional survey

The cross-sectional survey, which was based on the active abattoir, was conducted during routine meat inspection on arbitrarily selected cattle slaughtered at Awassa municipal abattoir. This system was employed until the total sample size required was attained. Prior to sampling, each animal presented to the abattoir for routine meat inspection was given an identification number. During meat inspection, the already identified animals and their respective organs were strictly supervised and examined. This is to avoid the unnecessary mixing with organs intended to be inspected.

Meat inspection was done in accordance with the Meat Inspection Regulation (1972), by the Ethiopian ministry of agriculture, which indicates meat inspection procedures in the detection of *C. bovis*. Visual inspection of all exposed surface was made in the heart, diaphragm, liver, kidney, lung, shoulder muscle, tongue and masseter muscle, and followed by incising routinely to examine for the *C. bovis* cysts. Lesion consist of cysticerci, they are 5-8mm by 3-5mm, translucid and filled with brownish fluid. Each organ was inspected according to the procedure, which stipulates that, the masseter muscles, tongue, heart and shoulder must be examined. For the masseter, two deep linear incisions were made parallel to the mandible from its upper muscular insertion. The tongue (also examined by palpation) was incised lengthwise on the lower surface from base to root while the heart was split from base to the apex and further incisions made into the muscle. Three deep, adjacent and parallel transverse incisions were made above the point of the elbow in the shoulder muscles. The pericardium was opened and incision was made in to the cardiac muscle from the base to the apex to inspect the heart muscle. Examination of the kidneys, diaphragm, livers and the lungs was made based on the standard method of meat inspection. In organs that were positive for *C. bovis*, the character and density of the cyst was recorded. Record of the slaughtered animals was kept on specially designed sheets. It comprised data of carcass identification number, age, sex, breed and number of cysts (Annex, 2) found in the inspection site suspected of *C. bovis*. Samples were

transported to the parasitology laboratory at the college of agriculture, Hawassa University for confirmation.

The viability of cysts were ascertained by placing them in a normal solution with 30% ox bile and incubated at 37o^{C}. The cysts were regarded as viable if the scolex evaginats after the incubation period. At the same time the scolex was checked whether it is *T. saginata* or other metacestode based on the size of cysticercus, absence of hooks on the rostellum of the evaginated cyst (Gracey *et al.*, 1999 and WHO, 1983). Bile used in the study was collected at the slaughterhouse from the gall bladders of apparently healthy cattle. The bile was pooled, centrifuged to remove any particulate material and stored at –20°C until required for use.

3.4.2. Questionnaire survey

For each of the randomly selected respondents (day laborers, merchants, students, drivers, butchers, university and high school teachers, civil servants and the household heads) in Awassa town and its peripheries, questionnaire survey for risk assessment was administered (Annex 1). The intention of this interview was to approximate the prevalence of *T. saginata*, relative frequency of taeniosis and to identify the risk factors associated with the transmission of infection.

3.4.3. Inventories of pharmaceutical shops

An inventory of pharmaceutical shops, rural drug vendors and health station pharmacies were conducted in Awassa town. This was based on their annual taenicidal drug sales (based on prescription and complaints of the patients) and doses that was gathered and analyzed to estimate the impact of taeniosis. In view of that, the sampling was based on selecting volunteer drug shops i.e. the first factor being sole drug importer and distributor for the southern part of Ethiopia, i.e. PHARMID, the Ethiopian Red Cross Pharmacy, the government and privately owned pharmacies and the rural drug vendors were selected.

3.5. Data management and analysis

Abattoir data was collected and recorded on specially designed forms and preliminary analysis was done in Microsoft® excel (2002). The outcome variables for the abattoir study were cases of *C. bovis* detected during routine postmortem inspection. STATA computer soft ware (Stata Corp., 2001) was used for analysis. The questionnaire data was coded and analyzed by the analysis of univariate risk factors using chi-square and odds ratio where as, multi variant factors were analyzed by logistic regression.

3.6. Ethical consideration

The study, which involved human subjects randomly selected from Awassa town and its surroundings, did not suffer serious ethical issues, as it was questionnaire survey. However, informed consent was obtained from the participants with the understanding that the names and any identification of the subjects were kept confidential.

4. RESULTS

4.1. Active abattoir survey

Of the 400 bovine carcasses examined during routine meat inspection at Awassa Municipal Abattoir 105 (26.25%) were found to be infected with *C. bovis*.

4.1.1. Breed

The breeds of animals used in this particular study were the local zebu and crosses of zebu with the Holstein Friesian breeds. Here the Holstein Friesian in particular and crosses in general do not come to the abattoir for routine meat inspection. This is because the number of crosses was very limited and they are kept for breeding purposes. Statistical analysis with intercooled Stata 7.0 revealed that the prevalence of bovine cysticercosis was significant between the breeds (Table, 8) of animals ($P<0.05$).

Table 8: Proportion of bovine carcasses infected with *C. bovis* in local and cross breeds.

Breed	Number of carcasses inspected	Number of infected carcasses	% of infected carcasses
Local	379	94	24.8
Cross	21	11	52.38
Total	400	105	26.25

$P<0.05$, OR = 3.34, 95%CI = 1.369574 - 8.1446

4.1.2. Sex of the animals

Nine (27.27%) from a total 33 female animals and 96(26.16%) from 367 male animals were positive for bovine cysticercosis. The statistical analysis showed that there was no significant difference (P>0.05) between the prevalence of bovine cysticercosis and sex of animals presented to the Awassa municipal abattoir during the study period. (χ^2 = 0.02, P > 0.05 and CI = 0.45 - 2.29).

4.1.3. Origin of the animals

Animals, which were presented to Awassa municipal abattoir for routine meat inspection, were from three directions i.e. from Arsi, Borena and Wolayta zones of the country. Farmers in these areas had their own managemental practice for their animal that is intended for sell on the market after fattening. The farmers had an experience of keeping and tying the animal to the homestead area and feed by cut and carry system. All the necessary materials that the farmer thought of to fatten his/her animals were brought to the place where the animal is tied. The animal has no chance to move from one place to another until it is sold. This seems a little bit that of the modern fattening practice and works for Wolayta and some of the Arsi farmers. But for the Borena cattle, it is obvious that these animals were from the pastoral (harsh environment) where it is not suitable for the development of the cyst to infect the cattle of this community. Traditionally, Borenas do not consume raw meat. The result of the present study revealed that there was no statistical significant difference (P>0.05) observed among the animals of different origin (Table, 9).

Table 9: Proportion of bovine carcasses infected with *C. bovis* by the origin of animals.

Origin	Number of inspected carcasses	Number of infected carcasses	% of infected carcasses
Arsi	217	63	29.03
Borena	100	21	21
Wolayta	83	21	25.03
Total	400	105	26.25

$P > 0.05$, OR = 0.87 and CI = 0.6512676 -1.156603

Analysis of the active abattoir survey showed that there was a significant variation in the anatomical distribution of viable cysticerci in organs inspected (Table, 10).

Table 10: Proportion of carcasses infected with *C. bovis*.

Organs							
Heart	Diaphragm	Masseter	Kidney	Lung	Shoulder	Tongue	Liver
45(11.25%)	7(1.75%)	34(8.5%)	1(0.25%)	2(0.5%)	36(9%)	13(3.25%)	3(0.75%)

4.1.4. Viability tests

A total of 500 cysts were collected at Awassa municipal abattoir during the study period. Of the total cysts collected, 221(44.2%) were found to be alive and 279(55.9%) were degenerated cysts (Table, 11). From the inspected carcasses at the abattoir, three animals were found to harbor an exceptional 25 cysts and one animal harbored 53 cysts. The carcass, which harbored 53 cysts, was totally condemned due to generalized tuberculosis.

It was found that those positive viable cysts were *C. bovis*, because; evagination took place with in 1-2 hours. Then the microscopic examination of the cysts showed thin bladder wall and the scolex with four suckers but no rostellum or hooks (Gracey *et al.*, 1999) by pressing between two glass slides.

Table 11: Proportion of viable cysts in different organs inspected.

Organs inspected	Total cysts recorded	Viable cysts
Heart	151	65(43%)
Diaphragm	29	12(41.4%)
Masseter	120	59(49.2)
Kidney	14	1(7.2%)
Lung	11	2(18.2%)
Shoulder	113	56(49.5%)
Tongue	46	23(50%)
Liver	16	3(18.75%)
Total	500	221(44.2%)

4.1.5. Logistic regression of the selected risk factors for the C. bovis infection

The logistic regression (Table, 12) of the selected risk factors for bovine cysticercosis was assessed and breed was the only significant risk factor for *C. bovis* infection.

Table 12: The logistic regression analysis of the risk factors for *C. bovis* cysts.

Risk factors	Odds Ratio	Std. Err.	Z	P>|z|	95% Conf. Interval
Breed	3.339873	1.519044	2.65	0.008	1.369574 - 8.144684
Sex	1.011888	0.4211382	0.03	0.977	0.4475795 - 2.287676
Origin	0.8679044	0.1271596	-0.97	0.334	0.6512676 - 1.156603

4.2. Questionnaire survey

120 volunteer respondents of the residents of Awassa town who were participated on different working environments; farmers, students, merchants, daily laborers, teachers, government workers, housewives, private workers (high and low risk groups) were included in this particular study. 64.2% of the interviewed residents had contracted *T. saginata.*

4.2.1. Age

Statistical analysis showed that the prevalence of *T. saginata* was significant with the age of respondents; the middle-aged groups of the respondents had relatively higher infection rates compared to those young and older ones. $P<0.05$ and $\chi^2 = 6.23$ and 95% CI =0.3222054-1.850297.

4.2.2. Sex

According to the interview conducted among the residents in order to judge the interaction of sex on the prevalence of *T. saginata,* it was found that sex had no statistically significant difference ($P>0.05$) on the prevalence of *T. saginata* taeniosis. 60.78% females and 66.67% male respondents had contracted taeniosis. The χ^2 and logistic regression of the prevalence of taeniosis by sex was $P>0.05$ and $\chi^2 = 0.44$ and 95%CI = 0 .4235692- 3.80096.

4.2.3. Religion

Interview was carried out among the residents based on their religion as to *T. saginata* infection and there was strong statistical association ($P<0.05$) observed between the religions i.e., Muslim and Christian (Table, 13). Christians were found to be contracting taeniosis higher than Muslim.

Table 13: The Prevalence of *T. saginata* in relation to Religion.

Religion	Taeniosis		Total
	Do not contract taeniosis	Contract taeniosis	
Muslim	13(59.09)	9(40.91)	22(100)
Christian	30(30.61)	68(69.39)	98(100)
Total	43(35.83)	77(64.17)	120(100)

P<0.05, OR = 5.34 and 95% CI = 1.27308- 22.40465

4.2.4. Occupation

In this study, the occupation of the respondents was from different working conditions i.e., day laborers, butcher men, cookers, abattoir workers and meat inspectors, farmers, students, government and private workers. But for the purpose of statistical analysis, the occupation was divided in to low and high-risk groups. The occupation that was grouped under high risk groups were those who had a strong relationship with meat and meat products; such as, abattoir workers, butcher men, meat inspectors, cookers and farmers. Whereas, the low risk groups were arbitrarily selected as those who do not have as such a strong relation ship with meat and meat products, i.e., government workers, teachers and the rest of the respondents. Therefore, the occupation (Table, 14) had strong statistical significance on the prevalence of taeniosis (P<0.001).

Table 14: Prevalence of *T.saginata* between the risk groups.

Occupation	Taeniosis		
	Do not contract taeniosis	Contract taeniosis	Total
Low risk groups	31(54.39)	26(45.61)	57(100)
High risk groups	12(19.35)	50(80.65)	62(100)
Total	43(36.13)	76(63.87)	119(100)

$P<0.001$, $\chi^2 = 15.79$ and 95% CI = 1.03 – 11.024

4.2.5. Educational background

The educational background of the respondents were divided in to three categories, namely, those who did not attend school were coded as formal education, those who attended schools up to junior high school were coded as middle level and those of college and university graduates ones as high level of education. Educational background had no statistical significance on the prevalence of *Taenia* infection ($P > 0.05$, OR = 0.71 and 95% CI = 0.29-1.69).

4.2.6. Raw meat consumption

The majority of the respondents had an experience of raw meat consumption as a result of traditional and cultural practices. The statistical analysis of the raw meat consumption and taeniosis interaction was statistically significant ($P<0.001$). Raw meat consumption is the favorite dish for most of the respondents and 64.17% of the respondents were the raw beef consumers who had contracted taeniosis (Table, 15).

Table 15: Effect of raw meat consumption on the prevalence of *T. saginata.*

Status of raw meat consumption	Taeniosis		Total
	Do not contract *T. saginata*	Contract *T. saginata*	
No raw meat	36(55.38%)	29(44.62%)	65(100%)
Raw meat	7(12.73%)	48(87.27%)	55(100%)
Total	43(35.83%)	77(64.17%)	120(100%)

P<0.001, OR = 8.47 and 95%CI = 2.58 - 27.84.

4.2.7. Use of spices

As it is traditionally practiced in the majority of the citizen, most of the residents of the study area had an experience of using the spices with raw and roasted meat, believed to increase the appetite. The spice is prepared from water, ox bile, and powder of red paper. Even though this spice is believed to increase the appetite of the consumer, it decreases the evagination time of the cysts and predisposes for infection. The use of spice with raw and roasted meat was statistically significant (P<0.001) (Table, 16).

Table 16: The use of spices with raw and roasted and the prevalence of *T. saginata.*

Spice	Status of taeniosis		
	Do not contract *T. saginata*	Contract *T. saginata*	Total
No spice	20(46.51)	23(53.49)	43(100)
Use spice	6(7.79)	71(92.21)	77(100)
Total	26(21.67)	94(78.33)	120(100)

P<0.001, OR = 12.03 and 95% CI = 2.94 - 49.19.

4.2.8. Marital status

There was a statistical significance between the interaction of the marital status and prevalence of taeniosis, $P<0.05$, $\chi^2 = 7.00$, 95% CI = 0 .5197695 -7.654246.

4.2.9. Logistic regression of the selected risk factors for taeniosis infection

The logistic regression using STATA soft ware indicated that five risk factors such as religion, occupation, raw meat consumption and use of spice were the most significant risk factors for the infection of taeniosis (Table, 17).

Table 17: The logistic regression of the selected risk factors for taeniosis.

Risk factors	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf. Interval]
Religion	5.238592	3.843548	2.26	0.024	1.243624 - 22.06684
Occupation	4.74726	2.510961	2.94	0.003	1.68352 - 13.38652
Raw meat	8.028091	4.6215	3.62	0.000	2.597792 - 24.80963
Spices	10.26194	6.925322	3.45	0.001	2.733959 - 38.5183

4.3. Inventories of pharmaceutical shops

An inventory of pharmaceutical shops (pharmacies, drug stores, and rural drug vendors) was conducted in Awassa town and its surrounding areas. It was noted that the modern taenicidal drugs sold in those shops were produced locally or imported from abroad (United States of America, Europe, Far East and some other African countries).

In this study area, private owned pharmacies were known by selling drugs more expensive than those pharmacies owned by Red Cross and Government. The residents also prefer those Red Cross and government owned pharmacies because, drugs are cheaper and also they

believe that those drugs from these pharmacies are more curable than that of the privately owned ones. Estimates of yearly adult taenicidal drugs dose and its worth collected through personal interviews with the pharmacies, their assistants or shop owners from 2002-2005 revealed that a total of 4,033,431 adult taenicidal drug doses (Table, 18) and a total worth of 7, 219,019.95 Eth. Birr (Table, 19). The inclination for taenicidal drugs revealed that Niclosamide was the first drug of choice among the residents due to its cheap price; where as, Praziquantel was the least preferred taenicidal drug as it is expensive for patients. The taenicidal drugs preference trend of the respondents in the study area were 62.5%, 56.67%, 53.33%, and 48.33% for Niclosamibe, Mebendazole, Albendazole and Praziquantel, respectively.

Table 18: Inventory of pharmaceutical shops for the annual taenicidal drugs dose in 2002 to 2005 in Awassa town, southern Ethiopia.

Name of taenicidal drugs	Years				
	2002	2003	2004	2005	Total
	Dose	Dose	Dose	Dose	Dose
Niclosamide	1,151,425	437,345	551,000	646,195	2,785,965
Praziquantel	26,500	47,600	14,700	0	88,800
Albendazole (bolus)	14,259	20,259	26,708	7,392	68,618
Albendazole (syrup)	5,146	8,119	1,197	19,060	33,522
Mebendazole (bolus)	163,280	368,440	288,760	157,580	978,060
Mebendazole (syrup)	4,800	39,500	29,995	4,171	78,466
Total	1,365,410	921,263	912,360	834,398	4,033,431

Table 19: Inventory of annual taenicidal drugs dose and their worth (2002-2005) in Awassa town, Southern Ethiopia.

Name of taenicidal drugs	Years									
	2002		2003		2004		2005		Total	
	Dose	Worth (Br.)	Dose	Worth (Br.)	Dose	Worth (Br.)	Dose	Worth (Br.)	Dose	Worth (Br.)
Niclosamide	1,165,044	1,165,044	451,425	428,853.75	556,520	1,113,040	673,480	1,346,960	2,846,469	4,053,897.75
Praziquantel	36,436	36,436	53,712	161,136	18,808	56,424	2,504	7,512	111,460	261,508
Albendazole (bol.)*	67,264	201,792	32,054	96,162	37,698	82,305.9	18,146	54,438	155,162	465,486
Albendazole (syp*)	5,146	10,806.6	14,545	30,544.5	1,629	3,420.9	20,492	114,319.8	41,812	159,091.8
Mebendazole (bol.)	302,664	453,996	629,288	943,932	301,200	451,800	170,765	256,147.5	1,403,917	2,105,905.5
Mebendazole (syr.)	5,700	12,255	39,980	85,957	30,475	65,521.25	4,371	9,397.65	354,526	17,3130.9
Total	1,582,254	1,880,329.5	1,221,004	1,746,585.25	946,330	1,803,300.15	889,759	1,788,774.95	4,913,346	7,219,019.95

bol.* = bolus

syr. * = syrup

5. DISCUSSION

5.1. Active abattoir survey

Taeniosis/cysticercosis occurs most commonly in the environments characterized by poor sanitation, primitive livestock husbandry practices and inadequate meat inspection and control. Bovine cysticercosis usually does not cause much morbidity or mortality among cattle, but it does cause serious economic problems in the endemic areas due to the condemnation of meat or downgrading of carcasses in light infections (Onyango – Abuje *et al.*, 1996) contributing to constraint in food security and safety. The presence of the adult worms in human intestines may cause ill health but is easily treated (Fan, 1997 and Walther and Koske, 1980). The economic losses as a result of the condemned and downgraded carcasses due to treatment or processing of carcasses for human consumption are substantial.

In East Africa, *T.saginata* cysticercosis has been reported as a widespread and extremely common (Urquhart *et al.*, 1996). The results of the present study are in agreement with the above statements.

The majorities of the animals presented to the abattoir for slaughter were from out side of the town and managed under extensive farming system. This farming system favors the contamination of grazing fields by human excreta. In addition to this fact, the animals are driven on foot for several days until they arrive at the market or the abattoir for slaughter. The road sides which are the main livestock routes of transport are often contaminated by drivers and passengers excreta. Roadsides appear greener compared to the surrounding areas on which animals often graze maximizing the risk of infection with taeniid eggs.

The majority of the findings in Ethiopia were based on surveys carried out on carcasses subjected to the routine meat inspection procedures. Hence, the same limitations with which meat inspection shares globally were reflected in the results of the present study. The prevalence of *C. bovis* among the carcasses inspected at Awassa municipal abattoir was 26.25%. This result is higher than the findings of Dawit (2004) (4.9%), Nigatu (2004(7.5),

Tembo (2001) (3.11%), Getachew (1990) (13.8%) and Amsalu (1989) (9.7%), at Gondor, Addis Ababa, Debre Zeit and Gondor, abattoirs respectively. The reason for the higher prevalence of bovine cysticercosis in this study might be attributed to the variation in the personal and environmental hygiene, culture and feeding habit of the population, method and quality of meat inspection. However, the prevalence of the present study is more or less in agreement with the findings of Hailu (2005) in East Shoa (17.5%), Hailemariam (1980) whole Ethiopia (30%) and Ahmed (1990) in Nekempt (21%) abattoirs.

In general, the findings of the present study revealed that there was light infection and this could be due to the fact that there was a practical limit to the number of incisions allowed because gross mutilation lowers the marketability of carcasses and also introduces contamination and many light infestations go undetected (Wanzala *et al.*, 2003). The other thing is that the management of animals that were coming to the abattoir differs from the management of the majority of other Ethiopian cattle. This is explained by the fact; for example, Boran cattle were from the pastoral community in which the environment might not be conducive for the development of cysts to infect animals and the Borena communities do not have the habit of raw meat consumption.

Analysis of the results of the present study demonstrated the significant positive relationship between breed and *C. bovis* infection ($P<0.05$). This finding might be influenced by the fact that the sample size not being proportional among the breeds *i.e.* it was 94.75% for local and 5.25% for cross breeds (Table, 8). Another possible explanation might be crosses are kept away from grazing, well managed than local breeds since they are kept for breeding purpose. It is also now recognized that local breeds are resistant to parasitic disease infections. However, Pawlowiski *et al.*, (2001), reported that there is a difference in geographical isolates of the parasite and in the breed of cattle as a possible factor affecting the distribution and prevalence of *C. bovis*.

In this study, there was no association ($P>0.05$) between sex and the prevalence of cysticercosis. Therefore, it is in agreement with reports of Hailu (2005) and Tembo (2001).

There are reports pertaining to the relationship between sex and the prevalence *C. bovis*, which states that there is no association between sex and prevalence.

Most of the animals originated from three regions i.e., Arsi, Borena and Wolayta Zone. There was no statistical difference ($P>0.05$) in the prevalence of bovine cysticercosis in relation to the origin of the animals. This could be wherever the origin of the animals, since the animals driven a long distance for a long period of time along the main road side where they exposed to contaminated pasture with human excreta before they reach at the market or abattoir.

In the present study, the most frequently affected organ with the highest number of cysts was the heart muscle and 43% of the cysts were viable (Table, 11). This is slightly higher than the findings of Hailu (2005) in East Shoa (21.54%), but slightly in agreement with that of Dawit (2004) at Gondor abattoir (37.84%). The proportion of viable cysts in the inspection sites was in the increasing order: tongue, shoulder, masseter, heart, diaphragm, liver, lung and kidney. The viability test of the cysts revealed that it was the tongue, which harbored the highest number of viable cysts (50%), which is in agreement with the reports of Amsalu (1989) at Gondor abattoir. Hailemariam (1980) reported tongue was the most commonly condemned organ in the study conducted in Ethiopia between 1972 and 1978. If that is the case, the majority of the people of Ethiopia have the habit of consuming raw tongue and "*milas senber*" which is the type of food prepared from a rumen fold and tongue. If it is consumed raw or undercooked, there is a possibility of contracting taeniosis. In Asmara abattoir, Fuad (1986) reported that 60.01% of livers were affected with *C. bovis*. However, 18.75% of the inspected livers were infected in this study, which is higher than the reports of Hailu (2005) (4.17%), Dawit (2004) (3.12%) and Ahmed (1990) (5.24%) respectively. The proportion of shoulder muscles affected with *C. bovis* was 49.5%, which is in agreement with the reports of Carlos *et al.* (2002)(46%), but higher than the reports of Hailu (2005)(32%) and Wanzala *et al.* (2003)(13.35%).

The logistic regression (Table, 12) was computed for the selected risk factor for bovine cysticercosis (breed, sex and origin of the animals). It revealed that breed was the only

significant risk factor for the infection of bovine cysticercosis among the animals slaughtered at Awassa municipal abattoir, higher in the crosses.

The method of meat inspection, the ability of the meat inspector to identify the cases, difference in the management and sample size and sampling method, the number of cuts, and other factors can contribute for the variation of the prevalence of bovine cysticercosis.

5.2. Questionnaire survey

The quality of questionnaire is an important tool in individual cases and in mass investigation for the detection of *T. saginata* in the carriers in the population (Fralova, 1982). The respondents who were questioned in the present study disclosed finding proglottids in their feces and underwear. This finding is also supported by the reports of OIE (2004) and WHO (1983). The supporting evidence for the occurrence of *T. saginata* among the respondents is that almost all of the rsidents of Awassa town do not eat pork. This is because of religious cult that confirms this current finding and eliminating possible differential diagnosis for *T. solium* and *T. asiatica.*

The prevalence of *T. saginata* among the population of Awassa town is 64.2%, which is very close to the findings of Hailu (2005) (79.5%), Dawit (2004) (69.2 %), Tembo (2001) and Derylo and Szilman (1995), (68%) in Ethiopia and Poland respectively. It is lower than the findings of Tembo (2001) (94.32%) in Addis Ababa. From this finding it is possible to estimate the significance of taeniosis in Awassa town. According to the report by Arundel (1972), more than 80% of native stockmen in Africa were infected with *T.saginata.* On the other hand, Woldemikael *et al.* (1990) reported 13.5% infection in this country. In Korea, Moon, (1976) reported that the prevalence rate of the infection rate in the range of 4.5% and 38% through the questionnaire survey. Cheruiyot and Onyango (1984) found out that 2-63% of the Kenyan populations were infected with *T. saginata* taeniosis. WHO (1983) (65%) and Fan (1988) (18%), of infection were reported infection rates in the people of Serbia and Montenegro and Taiwan respectively.

The present study showed that there was an association between age of the respondents and the prevalence of *T.saginata* infection (P>0.05), which is in an agreement with the findings of Hailu (2005), Dawit (2004) and Mulugeta (1997) in Ethiopia; higher in the middle aged groups. The probable explanation could be the chance of contracting Taenia infection in this age category is higher since they frequently visit butchers and restaurants.

In this study, the interaction between sex and the prevalence of *T.saginata* was not statistically significant (P>0.05). This is in a complete disagreement with the findings of Hailu (2005), Dawit 2004, Tembo (2001) and Mulugeta (1997) in Ethiopia and Moon (1976) in Korea, Dada (1980) in Nigeria, and Fan (1988) in Taiwan who found infections more frequent in males than females. However, Gracey *et al.* (1997) reported that females were found to be more frequently affected than males in a ratio of 2:1. In this study, there was no discrimination among males and females to consume meat in restaurants and butchers.

Statistical analysis showed that there was a strong association (P<0.05) between the prevalence of taeniosis and religion. From this study, the proportion of taeniosis infection was higher in the Christian community. This finding is in agreement with the findings of Hailu (2005), Dawit (2004) and Tembo (2001) in this country. The higher proportion of infection in the Christian community could be due to the fact that raw meat is their favorite dish. While, properly cooked meat is the favorite and choice of dish among the Muslim community. In addition to this fact, Christians celebrate many festivals annually and at the same time there is a tradition of raw meat consumption and there by contract taeniosis.

The interview conducted among the residents from different professional backgrounds revealed that there was a significant difference (P<0.001) observed in the high-risk groups. The professional category of the respondents was grouped arbitrarily as low and high-risk groups. The high risk groups were those who have strong relationship with meat and meat by products, such as (farmers, butcher men, cookers, and abattoir workers). Where as, low risk groups were those who do not have as such strong access to meat and meat by products (government workers, teachers and students). The result of this study was in an agreement with the findings of Hailu (2005), Dawit (2004) and Tembo (2001) in Ethiopia and the

majority of researches in the world. This is due to the fact that the high-risk groups have higher access to come in contact with meat and meat products. As a result of this there could be a possibility of getting infection with *Tania saginata* taeniosis.

There was no variation in the occurrence of taeniosis among the people with different educational backgrounds ($P>0.05$). The possible suggestion could be the deep-rooted culture of raw and undercooked meat consumption regardless of education level in this country.

Analysis of the results of the present study also demonstrated the significant positive relationship between raw meat eaters and infection of taeniosis ($P<0.001$) that is in accordance with finding of Hailu (2005), Dawit (2004) and Tembo (2001). This indicates that raw meat consumption is the main risk factors to be controlled in order to avoid the infection in man by *C. bovis*. The transmission of *T.saginata* infection from animals to man depends on the human habit of eating raw or semi-raw meat dishes like '*kitifo*' in Ethiopia and in other countries like meat tartar shashlik in Union Soviet Socialist Republic (Abdullaev, 1968), baserterma in near east (Nagaty, 1946), shish kebab and tikka in India (Anataraman, 1974), larb in Thailand (Chularerk *et al.*, 1967) or pieces of meat simply roasted over an open fire in central and East Africa (Carmichael, 1952).

There is a strong association ($P<0.001$) between the use of spice and meat consumption (Table, 16). The spice was locally prepared from ox bile, water, and red paper powder. Since the spice contains the ox bile, which was used in the materials and methods part of this study as the viability test; it enhances the evagination of the viable cysts. There fore, when a person consumes raw and roasted (improperly) meat with spice, if the cyst is viable, this spice is might facilitate the evagination of the cyst in the intestine. In other words, it decreases the evagination time of the cyst during the infection process.

The interaction between the marital status and the prevalence of *T. saginata* revealed that there was a significant different ($P<0.05$) between married and single respondents, higher in the married ones. This could be due to the fact that married communities had strong economic power to visit butchers and restaurants. Furthermore, there is a chance of being infected by tasting meat during mixing and cooking among the married communities. In urbanized

society, for example in Poland, of the 90% of carriers who admitted to eating raw meat, 44% ate it exclusively at home (mostly married women and children), 22% exclusively outside of the home (mostly single men and women), and 24% both at home and public places (mostly married men (WHO, 1983).

Complaints by taeniosis suspected patients who were visiting clinics, hospitals and drug shops were hunger, constipation, epigastiric pain, weakness, increased appetite, decreased appetite, dizziness, headache and loss of weight. The taenicidal drugs, which were frequently prescribed based on the complaints of patients were, Niclosamide, Albendazole, Mebendazole and Praziquantel. Of the available drugs, Niclosamide was the drug of choice among the respondents; this is because the price of the drug was cheaper compare to other taenicidal drugs. Niclosamide was introduced into human medicine for the treatment of tapeworm infections in 1960 and it is claimed to be the drug of choice with a high level of safety (WHO, 1983). Praziquantel was the least preferred drug, since it is more expensive than the others despite the fact that it is an effective drug.

Computing the Logistic regression for the selected risk factors of taeniosis revealed that religion, raw meat consumption, occupation and use of spices were found to be important risk factors for taeniosis (Table, 17).

5.3. Inventories of pharmaceutical shops

Despite the fact that the pathogenic significance of *C. bovis* is considered to be very low (Soulsby, 1982), human taeniosis has both economical and aesthetic importance. However, evaluation of the economic aspects is very difficult particularly in countries like Ethiopia, where infected people are used to treat themselves with traditional herbal drugs. One of the probable sources of information to evaluate the economic feature is to carry out inventories of pharmaceutical shops, which still cannot reflect the actual economic impact of the disease. However, inventories of pharmaceutical shops from 2002-2005 in Awassa town during the study period indicated that 4,033,431 doses of taenicidal drugs (Table, 18) with the annual estimated costs that resulted from taeniosis treatment 7,219,019.95 Eth. Birr was recorded

(Table, 19). This indicates that taeniosis diminishes the household financial resources which could be easily avoided by eating well-cooked meat dishes.

The prevalence of *T. saginata* vary from country to country and with in the same country also difference from area to area. The variation could be due many factors; such as, variation in the habit of raw meat consumption, awareness of patients about the clinical pictures of the disease, variation in personal and environmental hygiene, and other factors related could contribute to the variation in the prevalence of taeniosis among countries.

6. CONCLUSION AND RECOMMENDATIONS

T. saginata is a medically and economically important cestode parasite, while infection with the cysticercus larval stage in cattle causes economic loss in the meat industry. In this study, the prevalence of bovine cysticercosis determined by the active abattoir survey was relatively higher than the reports by different researchers in different parts of the country. The questionnaire survey also indicated that taeniosis is a widespread problem among the residents of Awassa town and its surroundings. Among the potential risk factors, religion, occupation and consumption of raw meat were very important risk factors for taeniosis. Furthermore, it was also observed that the use of spices during raw and undercooked meat consumption increases the infection rate of *T. saginata.* Inventories of pharmaceutical shops indicated that *T. saginata* taeniosis has significant economic impact. Based on the findings of the present study, the following are recommended:

- There should be a public awareness about the health and economic significance of the disease through the available media and strengthening of training with special reference to the danger of raw or undercooked meat consumption and use of toilets/latrines.

- Improvements in working conditions of the inspectors with upgrading their skills and working conditions.

- Infected meat and meat products must undergo the process of freezing, boiling or destruction of the cysticerci based on the intensity of infection.

- There should be strong and close collaborations between medical and veterinary professionals to reduce the impact of the disease in both human and cattle population.

- The rural community should construct simple toilets/latrines in order to improve sanitation and hygiene.

- The Meat Inspection Regulation Act 428 of 1972 of Ethiopia under which meat inspection is carried out should be reviewed. While reviewing the Act, factors such as, eyesight of inspectors, inspection procedures and light in the abattoirs and proper bleeding and cleaning of carcasses before examination should be addressed adequately. Proper implementation of such procedures will help improve the prevailing situation.

- Further study should be conducted to examine the effect of spices on the infection process of taeniosis.

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8. ANNEXES

Annex 1: Questionnaire Survey (Bovine Cysticercosis/Taeniosis)

Region _____ Zone_____

District _____ Date_____

Village _____ Code_____

Address_____

1. Respondent's age categories.

0-15, __ 16-20, _ 21_25, 26-30, ___ 31-40, __ above ___

2. Sex: Female _____ Male_____

3. Religion: Christian___ Moslem _____ Others_____

4. Occupation _____

5. What was the highest level of education attended?

Formal education____ Elementary____ Junior high school_____ College (diploma) ___ University____

6. Which species of livestock do you own? Cattle____ Small ruminants___ Equines ____

7. If cattle are communally grazed, how far is grazing land from the living quarter? _____

8. Are there any latrines in the areas where cattle are grazing? Yes___ No___

9. Do you have any and use latrine at your homestead? Yes_____ No_____

10. Please rank in order of your favorite (8=best, 1= least), the following foodstuffs (the same rank could be given for more than one item) Semi-roasted minced meat ("leb-leb kitfo") ____ Raw meat ("kurt") _____ Properly cooked minced meat ("yebesele xibs kitfo") ___ Raw minched meat ("xire kitfo") ___ Raw tongue and rumen folds ("melase senasenber") __ Properly roasted meat ("xibs")___ Roasted intercostals muscle (yegoden tibs)___ No preference_____

11. Have you ever suffered from taeniosis? Yes ___ No___

12. Have you observed any symptoms of illness whenever you get infected with tapeworms? Yes _____ No_____

13. If yes for question 12, above which one (s) of the following symptom have you noticed?

Diarrhea____ Hunger pain___ Constipation____ Epigastiric pain____

Weakness____ Increased appetite____ Decreased appetite_____

Dizziness_____ Head ache_____ Loss of weight ____

Disturbance by crawling *T. saginata*_____

14. How many people in your household have suffered from tapeworm infection?

_____

15. Which of the following taenicidal drugs have you used in the past to treat yourself?

Modern drugs available in pharmacies

Vermox (Mebendazole) ____ Kosso farm (niclosamide) _____

Diclorophen_____ Praziquantel_____ other specify_____

Traditional taenicidal drugs commonly used in Ethiopia

"Kosso"_____ "Enkoko"_____" Meterie"____ "Duba fire"_____

Other specify_____

16. How often did you take taenicidal drugs? _____

17. Where do you get the taenicidal drugs?

Pharmacy_____ Herbalist_____ Home preparation_____

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

Modern_____ Traditional_____

19. How much does a single dose of tapeworms treatment cost you?

Modern_____ Traditional_____

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

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

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

Yes _____ No_____

If yes,

	Only once	rarely	commonly
Modern drugs	_____	_____	_____
Traditional drugs	_____	_____	_____
Both	_____	_____	_____

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

23. Have you ever heard of serious complications (death) from taking taenicidal drugs? Yes _____ No_____

24. Do you know the cause of tapeworm infections?

Yes_____ No_____

25. In your opinion, which food of animal species serves as a source of human tapeworm infection?

Cattle _____ sheep____ goat_____ camel____ poultry_____ fish____

26. Do you recognize tapeworm infection from the meat? Yes _____ No_____

27. How do animals get the cyst? _____

28. In the identified animal above question 27, which organs, or tissue or parts of the flesh do you think contain the infective form of the parasite?

_____

29. Do you believe that butchers informs their customers on weather the meat is infected or not? Yes _____ No_____

30. Do you think tapeworm infection taeniosis can be prevented? Yes____ No____

31. If yes, state how it could be achieved? _____

32. Do you use spice? Yes_____, no_____

32. Marital status: Married_____Single_____

Annex 2: Recording sheet for abattoir survey.

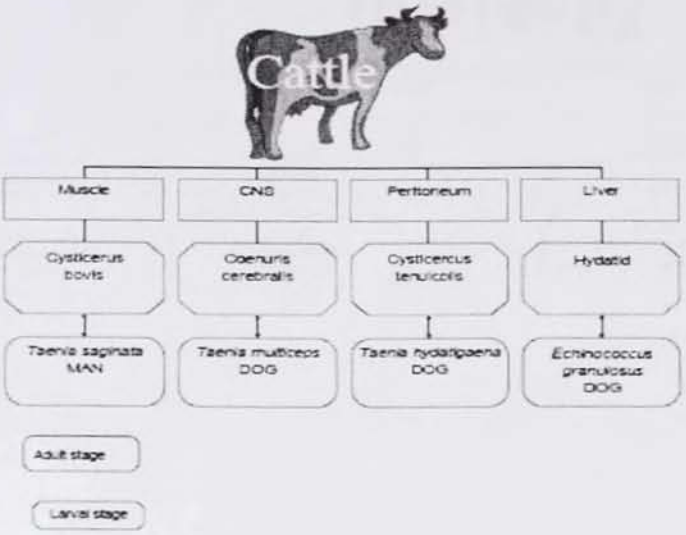
Date	ID	Lot. No	B	O	SX	A	VC	DC	Organs to be inspected	Remark
									H, S, M, LV, L, K, D	

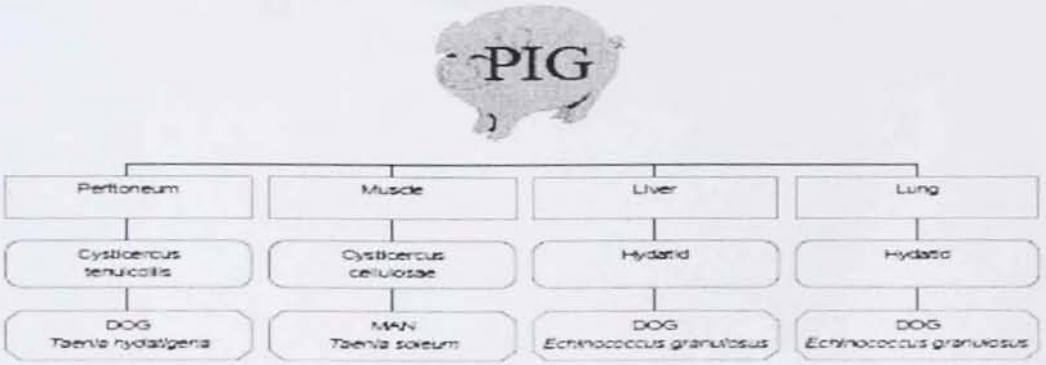
Key: ID = animal identification number, B = Breed, O = Origin, SX = Sex, A =Age, VC = Viable Cyst, DC = Dead Cyst, H = Heart, S = Shoulder, M=Masseter, L = Lung, K= Kidney, D = Diaphragm, LV = Liver

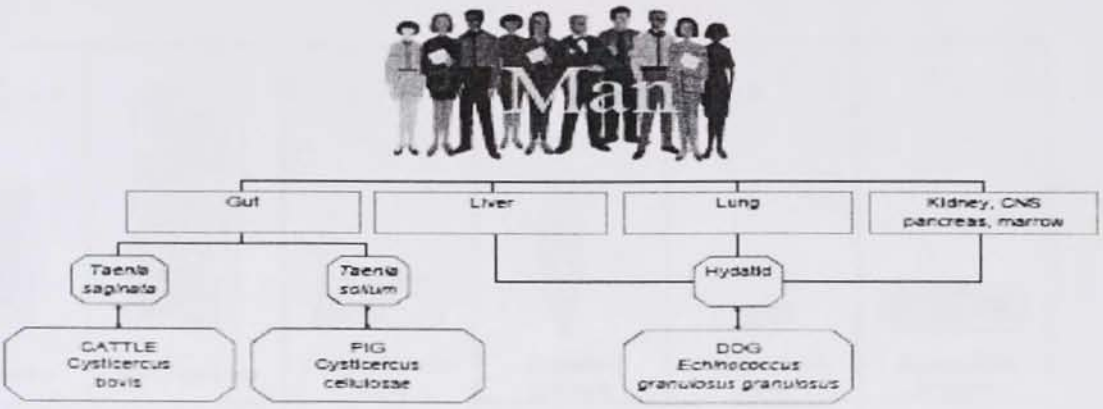
Annex 3: Consequences of taeniosis/cysticercos is in man and animals in short.

Man	Adult tapeworm in the intestinal tract (taeniosis) shedding of proglottids and/or eggs with the faeces.
1) *T. saginata* and T. solium	Mild clinical symptom
2) *T. solium* only	Cysticercosis in organs, subcutaneous tissues. The larval stage of the tapeworm (cysticercus) is embedded in muscles, liver/lung, or directly under the skin. Depending on the number and localization of cysticerci moderate to sever symptoms. Neuro cysticercosis. The larval stage of the tapeworm is embedded in brains and/or eye. Severe clinical symptoms
3) Cattle (*T. saginata*)	Cysticercosis in muscle. The larval stage of the tapeworm (cysticercus) is embedded in musculature of cattle throughout the body. No clinical symptoms, however abattoir diagnosis is made by (the rather
4) Pigs (*T. solium*)	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 carcase only

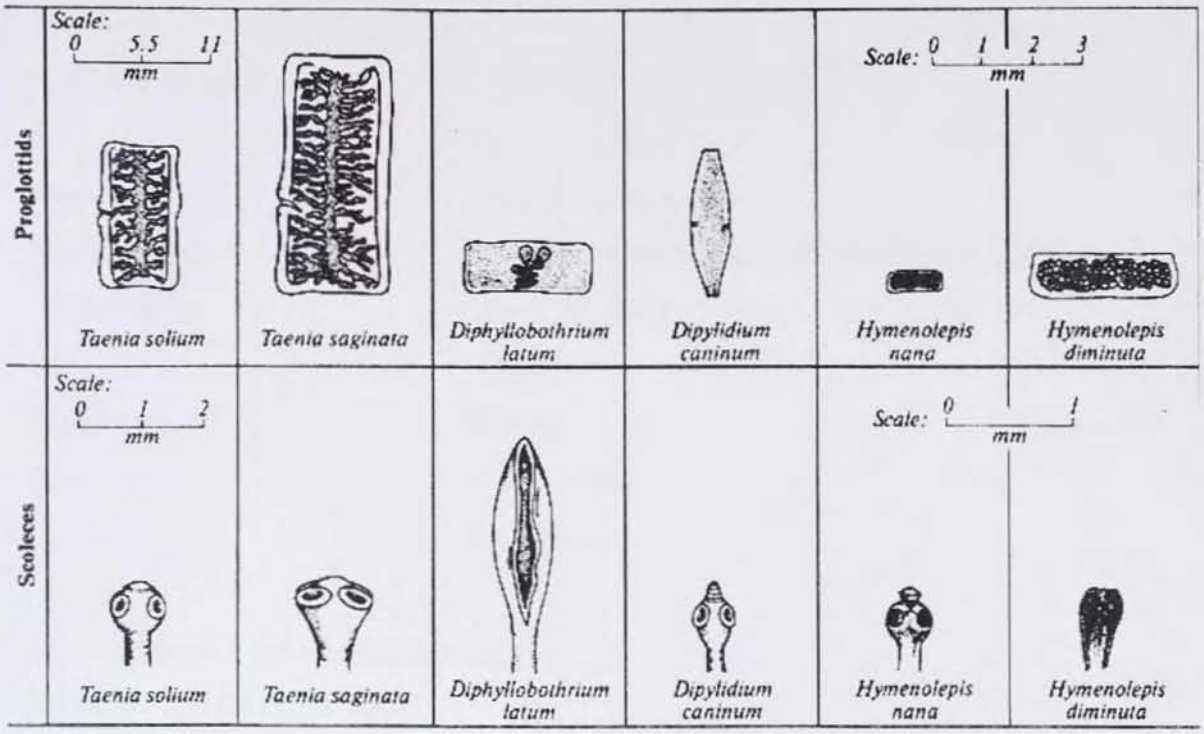
Annex 4: The predilection sites of some cestodes in different species of animals.






Man
Gut
Liver
Lung
Kidney, CNS
pancreas, marrow
Taenia
saginata
Taenia
solium
Hydatid
CATTLE
Cysticercus
bovis
PIG
Cysticercus
cellulosae
DOG
Echinococcus
granulosus granulosus

Annex 5: Proglottids and scolex of some cestodes.



9. CURRICULUM VITAE

A. PERSONAL DATA

Name:	Fufa Abunna Kurra
Place of birth:	Oromia, West Shoa Zone, Gindeberet District
Date of birth:	April 28, 1977
Sex:	Male
Marital status:	Married
Professional:	Veterinarian
Nationality:	Ethiopian

Email address = drfufex@yahoo.com
Mobile = +251-911-89 94 35

B. EDUCATIONAL BACKGROUND

1. University

- 2004–2006 - Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Master of Science.
- 1994–1999 - Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, DVM.

2. High School

- 1990–1993 - Gindeberet secondary school.

3. Elementary and Junior high School

- 1982–1989 - Gitire elementary and junior secondary school.

Computer: Dos, Window, Word, Access, different soft wares and Introduction to Internet.

C. SEMINARS AND PUBLICATIONS

1. Seminar on the Pathophysiology of copper deficiency in ruminants at Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, 1998.

2. F. Abunna, (2004): A study on the hematological value of local Menz sheep at the central high land of Ethiopia, North Shoa, DVM Thesis (*in press*).

3. M. Tibbo, K. Aragaw, F. Abunna, M. Woldemeskel, A. Deressa, M. Lemma Dechassa, J. E. O. Rege, (2005*):* Factors affecting hematological profiles in three indigenous Ethiopian sheep breeds. *Comp Clin Path 13: 119–127.*

4. Seminar on Review of the Prevalence and Economic impact of Bovine cysticercosis/ *T. saginata* , Addis Ababa university, Faculty of Veterinary Medicine, 2005.

D. WORK EXPERIENCE

- December 2000 – June 2001-Tigray national state, Wolkaite district as a field veterinarian.
- July 2001–Nov. 2001-Gambella regional state as an expert of Epidemiology unit in National Livestock Development Program (NLDP)
- December 2001–August 2004 - Ministry of Agriculture, Oromia Region, Arsi Zone, Merti district as team leader of Veterinary Sector for four years and as a facilitator in the Oromia women development initiative project.

E. LANGUAGE

	Read	Speak	Write
Afaan Oromoo*	Excellent	Excellent	Excellent
English	Excellent	Excellent	Excellent
Amharic	Excellent	Excellent	Excellent
Tigrigna	Good	Good	Good

*** Mother tongue**

F. MEMBERSHIP

Member of Ethiopian Veterinary Association

G. CONFERENCES, SEMINARS AND WORK SHOPS

- Participated in some conferences, seminars and workshops prepared by Governmental and Non Governmental Organizations.
- A three weeks training on the capacity building of women organized by Oromia women initiative development project conducted at Adama, 2004.

H. HOBBY

To read scientific articles, watching films and visiting historical places.

I. REFERENCES

- Dr. Merga Bakana (Associate professor) and Dean of the Faculty of Veterinary Medicine/AAU, Tele 011-4338557/011-4338533, P.O.BOX, 34, Debre Zeit.
- Dr. Getachew Tilahun, (Associate professor), Institute of Pathobiology/AAU, Tele: -1135728, Addis Ababa.
- Dr. Moges W/ Meskel, University of Tennessee, 2407 River Drive, Knoxville, Tennessee 37919, USA.

10. SIGNED DECLERATION SHEET

I, the undersigned, declare that the thesis is my original work and has not been presented for degree in any University and all sources of materials used for the thesis have been duly acknowledged.

Name: _____

Signature: _____

Date of submission: _____

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

Advisor:

Name: _____

Signature: _____

Study On The Prevalence Of Bovine Cysticercosis In Awassa Municipal Abattoir &Taenia Saginata In Awassa Town & Its Surroundings, South Ethiopia

FUfa Abunna