



Review: Metacestodes in Export Abattoirs of Ethiopia and their Economic Impacts



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Abstract

The distribution is associated with economic conditions, religious beliefs and the close proximity of humans to cattle in utility function. *T. saginata* is wider in developing countries where hygienic conditions are poor and where the inhabitants traditionally eat raw or insufficiently cooked meat. The infection is also a problem in developed countries where undercooked beef steak is consumed. It is important to note that eggs have been demonstrated to survive almost all stages of sewage treatment. It is significant; to that even the high standard of meat inspection in abattoirs of highly developed countries that are expected to identify measily beef carcasses has not succeeded [1]. In addition to this, the construction of well-equipped abattoirs and the enhancement of awareness of people about the economic and public health importance of the disease are also crucial. Our findings indicate that CE imposes a significant economic burden on Ethiopia export abattoir. They also emphasize the importance of maintaining or reinforcing current control measures to consolidate the progress achieved and to reduce human and animal infection rates. Further work is required to evaluate the cost-effectiveness and cost-benefit of any control programs implemented, and to guide decision makers and stakeholders on the best approach to take with the resources available. Better coverage and accuracy of the current surveillance systems are needed, as are improvements in the cooperation between the central and regional administrations, and the institutions responsible for collecting, providing and epidemiological relevance.

Keywords: Hydatid cyst; *Cysticercus Bovis*, *Taenia solium* (*Cysticercus cellulosae*)

Introduction

Taeniosis and hydatidosis are parasitic zoonoses that present major public health problems in lower income countries (Taylor et al., 2007). Bovine cysticercosis, refers to the infection of cattle with metacestodes of the human tapeworm *Taenia saginata*. *Bovine cysticercosis* is a major problem for producers in sub Saharan Africa. The clinical effect of cysticercosis on infected animal is generally not significant, however, in addition to the effect on human health, economic losses may be high due to the condemnation of heavily infected carcasses and the necessity to freeze or boil infected meat, restriction of export and herd quarantine. Hydatidosis is a zoonotic infection caused by adult or larval stage of cestode belonging to the genus *Echinococcus*. Hydatid disease (Hydatidosis) is characterized by cyst containing numerous tiny protoscolices that most often develop in the liver and lungs and also develop in the kidneys, spleen, nervous tissue, bone and other organs.

The nation's domestic meat consumption of about 45% comes from cattle, which generates export income mainly from the sale of live animals. In foreign trade, although the country is ideally placed to export live animals to the big markets of the Middle East and substantial markets of North and West Africa, export earning

is relatively low. This is mainly due to the presence of a number of unimproved animal health problems, among which, *Taenia saginata* (*T. saginata*) or *Cysticercus bovis* (*C. bovis*) is one that remains a major public and animal health problem. As parasites, flatworms have extended their global presence by taking advantage of the adaptations of many diverse invertebrate and vertebrate hosts. Many parasitic forms are host-specific and many of these are site specific within or on their host. Contemplate on the biodiversity of vertebrates; consider that many platyhelminths use one or more intermediate hosts and one may just begin to grasp the diversity of parasitic flatworms. From the microscopic interstitial free-living species that live between particles of mud to the enormously long tapeworms of blue whales, an estimate of 100,000 extant species, of which only about 20,000 have been formally described, still seems conservative when we consider the hosts and habitats yet to be surveyed. Even among those hosts and habitats already surveyed, many of the smaller parasitic species seem to have been overlooked and new species from commonly collected hosts are not uncommon.

Animal diseases are one of the most important constraints to increase productivity of food animals in all parts of the world.

Parasitism is one of the major problems that affect the productivity of livestock worldwide. Among many parasitic problems of domestic animals, tapeworms are an economically important intestinal parasites found all over the world, which have infected human beings for thousands of years. Bovine cysticercosis is a disease that affects the muscle of cattle and is caused by the metacestode stage of the human intestinal cestode, *T. saginata*. It is cosmopolitan in its distribution and it occurs in developing as well as in developed countries. The adult *Taenia* infection in man is referred to as Taeniasis and that due to the larval stage cysticercosis.

The distribution is associated with economic conditions, religious beliefs and close proximity of humans to cattle in utility function. *T. saginata* is wider in developing countries where hygienic conditions are poor and where the inhabitants traditionally eat raw or insufficiently cooked meat. The infection is also a problem in developed countries where undercooked beef steak is consumed. It is important to note that eggs have been demonstrated to survive almost all stages of sewage treatment. It is significant; to that even the high standard of meat inspection in abattoirs of highly developed countries that are expected to identify measly beef carcasses has not succeeded [1].

In Ethiopia, environmental sanitation and hygienic conditions are poor and raw beef consumption is common. Backyard slaughtering of domestic animals, particularly, cattle, sheep and goats; and feeding stray dogs with condemned organs are common practices. These habits would promote the transmission of cestode infections in Ethiopia. However, the information on status of the problem is not enough.

Hence, the purpose of this review is

- a. Determine the prevalence, distribution of cysts and economic significance of metacestodes in slaughtered animals at export abattoir in Ethiopia.

Major Metacestodes in Export Abattoir in Ethiopia and its Distribution

Humans are the only definitive host of the cestode *Taenia saginata* (beef tapeworm). The intermediate host of the larval form of *T. saginata* is mainly cattle. In cattle the eggs develop into the larval stage, *Cysticercus bovis* Non-viable cysticerci undergoing degeneration can vary in appearance depending on the degree of inflammation, necrosis, and mineralization in the resulting lesion bovine cysticercosis can inflict serious economic losses to the cattle industry. These are mainly due to condemnation, refrigeration and downgrading of infected carcasses. histological evaluation of *T. saginata* cysticerci suspect lesions is still considered the only laboratory diagnostic tool suitable for routine confirmation of undiagnosed lesions during inspection procedures at slaughterhouse. There have been many studies to characterize the histopathology of cysticercosis, however none of them gave a practical and unbiased set of criteria in order to come to a sound-based diagnosis [2].

The effect of the parasite in live small ruminants is insignificant unless it is complicated by the presence of concurrent infections. However, the presence of *C. tenuicollis* in ruminants is an indicator of the Bovine cysticercosis is a muscular infection of cattle and is caused by larvae of the human intestinal cestode *Taenia saginata*. Its life cycle is entirely dependent on the link between man and cattle so that any break in this links can result in the total elimination of the parasite. Tapeworm infections have been recorded in history from 1500 BC and have been recognized as one of the earliest human parasites. Cysts of *C. bovis* can be found anywhere in the carcass or meat and viscera. The distribution of *T. saginata* is wider in developing countries where hygienic conditions are poor and where the inhabitants traditionally eat raw meat or insufficiently cooked meat. Forty percent (40%) of the cases were reported in Africa. Researchers reported that this disease is very common in developing countries like Ethiopia. It is associated with poor hygiene and local factors including cultural background, (eating raw meat "Kurt", Kitfo" semi cooked meat), economic condition and religious beliefs, close proximity of humans to cattle kept with little or no distinction between companion or utility functions [3].

Hydatid Cyst

Hydatidosis (Cystic echinococcosis) caused by the larval stage (metacestode) of *Echinococcus granulosus*'s the most widespread parasitic zoonoses. The larval stage (Metacestode) of this tapeworm has both public health and economic significance. Despite the great efforts that have been put into the research and control of echinococcosis, it still remains a disease of worldwide significance. Dogs are the usual definitive hosts whilst a large number of mammalian species can be intermediate hosts, including domestic ungulates and man. The disease occurs throughout the world and causes considerable economic losses and public health problems in many countries, Hydatidosis causes decreased livestock production and condemnation of offal containing hydatid cysts in slaughterhouses.

Morphology of hydatid cyst: The larval stage of *Echinococcus* is a fluid-filled bladder or hydatid cyst that is unilocular, although communicating chambers also occur. Growth is expansive, and endogenous daughter cysts may be produced. Individual cyst may reach up to 30 cm in diameter and occur most frequently in liver and lungs but may develop in other internal organs. The infection with this stage is referred to as cystic hydatidosis. Hydatid cyst of *E. granulosus* is unilocular. Its growth is expansive by concentric enlargement. A well-developed cyst contains three layers; fibrous capsule of host origin. The middle one is the laminated membrane which is secreted by the thin (germinal) layer and therefore is of parasite origin. The germinal layer gives rise to the broad capsule and daughter cysts. The cysts are mainly found in the liver (and every possible organ: spleen, kidney, bone, brain, tongue and skin) and asymptomatic until their growing size produces symptoms or accidentally discovered.

Distribution of Hydatid cyst: The prevalence of hydatid cyst in sheep in Greece, China, Italy, Ethiopia, India, Azerbaijan and

Pakistan have been reported to be 100%. In Iran many studies have been performed; in Sanandaj area, western Iran and Kashan area, results indicated an infection rate of 51.9%. In some areas of the world, cystic echinococcosis caused by *E. granulosus* is a reemerging disease in places where it was previously at low levels. Hydatid disease is a problem in Asia, the Mediterranean, South America and Africa and also the prevalence of the disease has increased in Europe and North America in recent years. In Africa *E. granulosus* has been recognized from most countries including Ethiopia. Previous and recent report has described the endemic occurrence of *E. granulosus* in dogs and livestock. Most of the studies were focusing only on the prevalence and economic significance of the diseases prevention and controls, it is very important to know public perception about the diseases to specific agroecological zones with respect to socio-economic status. Thus, it would be essential to have information on occurrence of the diseases, financial loss and public health significance at the study area. Thus, the study was design to determine prevalence and public health significance, and to estimate financial loss due to Ovine hydatidosis at Adama Municipal Abattoir, Eastern Ethiopia [4].

In Ethiopia, study conducted from November 2009 to April 2010 with a purpose to assess the prevalence and economic significance of hydatid cyst in slaughtered sheep and goats at Modjo Modern Export Abattoir (MMEA), Ethiopia. The result of this study revealed that a total of 1115 small ruminants (348 sheep and 767 goats) were randomly sampled and examined after slaughter for the presence of hydatid cysts in the visceral organs (lungs, livers and hearts) and on muscles of the animals using the standard meat inspection procedures, where 97 (8.7%) were positive. The positive samples were taken to the laboratory for the cyst identification; fertility and viability test were performed. The study indicated that the prevalence of the hydatid cyst in the study area was 28 (8.05%) in sheep and 69 (8.99%) in goats which showed no significant variation between the two species. The distribution of cysts in the internal organs showed little significant variation between two organs (Lung and liver) in both animal species ($c2 = 0.272, P>0.05$). From the total examined sheep, 22

(78.6%) of the lung, 9 (32.1%) of liver and 1 (3.6%) of the heart which in goats was, 37 (53.6%) for lung, 27 (39.1%) liver, 0 (0%) heart and 4 (5.6%) muscles, respectively. Lung was the most commonly affected organ both in sheep and goats [5-7].

Economic impact of hydatidosis: The economic significance due to hydatidosis in Ethiopia, significant degrees of monetary losses was estimated at various levels in different locations. Such reported estimates indicate annual losses of 25,608 ETB (2,807.89 US\$) by Kebede in Tigray; 1,791,625.89 ETB (131,737.19 US\$) in cattle slaughtered at the Hawassa municipal abattoir (Regassa et al., 2010); 473,173.75 ETB (51,883 US\$) by Kebede in cattle slaughtered at the Debre Markos abattoir; and 52,828 ETB (5,869.8 US\$) in cattle slaughtered at the Adama abattoir.

Cysticercus bovis

Human cysticercosis is a neglected zoonotic disease caused by the larval stage of the parasite *Taenia solium*. This disease is responsible for severe health disorders such as seizures, and in some cases even death. *T. solium* cysticercosis is endemic in countries in Africa, Latin America and Asia where conditions such as inadequate hygiene, poor sanitary conditions, open defecation, free roaming pigs and poverty permit the transmission of the disease. Diagnostic tools are capable of detecting exposure to eggs and infection levels in a population through antibody and antigen detection, respectively. Understanding the epidemiology of cysticercosis in endemic regions will help expose information on the transmission, which could in turn be used to design appropriate control programs.

The larval stage/Cysticercus bovis/: The cyst is round or oval in shape, and when fully developed, consists of a scolex, invaginated into a fluid-filled vesicle (tail bladder), which is surrounded by connective tissue capsule formed by the reaction of the tissue of the host. The cyst is seen as small whitish vesicle and is found between muscle fibers. It is transparent and contains translucent fluid. The invaginated scolex is visible in the form of whitish spot at one end of the pole of the cyst. As in the adult tapeworm, it has neither rostellum nor hooks. *Cysticercus bovis* in muscle (histology).

Table 1: Bovine cysticercosis in different parts of Ethiopia.

Place	Percent Prevalence	Reference
Addis Ababa, Ethiopia Nigatu	13.3%	Kebede et al., 2009
Addis Ababa, Ethiopia	2.2%-3.3%,	Gebro-Emanuel Teka, 1997 Mulageta Alemu, 1997
DebreZeit, Oromia Getachew	13.85%	Belayneh, 1990
Wolaita Soddo (Southern Ethiopia)	11.3%	Alemayehu Regassa et al., 2009
Mekelle, Adigrat, Wukro (Tigray region)	8.29%	Kumar and Gebretsadik Berhe, 2008
Mekelle (Tigray region) Southern Nations Nationalities	7.23%	Abay Getachew, 2008
People's Region (Southern Ethiopia) Amhara National Regional State,	26.25%	Fufa Abunna et al., 2008
Ethiopia	18.49%	Nigatu Kabede, 2008
Bahir Dar (Amhara region)	19.4%	Alemu Mulugeta, 1997

Nekemta, Oromia	21.7%	Ahemed, Ibrahim, 1990
Gonder, (Amhara region)	-	Amsalu Demissie, 1989); Shimelis Dawit, 2004
Shoa, Ethiopia	-	- Hailu Degefu, 2005

Distribution of *C. bovis*: In developing countries, taeniasis/bovine cysticercosis constitutes a serious but less recognized public health problem. Due to the habit of eating raw or undercooked beef dishes such as kourt and kitffo, taeniasis in human is common in Ethiopia. A high (89.41%) prevalence of human infection in different agro-climatic zones of the country has been reported. Low availability of taenicides is a constraint and the use of herbal drugs do not eliminate this parasite from human population and the proglottids are passed out with the faecal matter resulting in cysticercosis in the cattle. In Ethiopia prevalence rate changing between 13.7 to 72.44% in cattle and 9.9 to 35% in sheep was described. Ethiopia is divided into nine ethnically based administrative regions and three chartered cities and bovine cysticercosis has been reported from different parts of the country (Table 1) [8].

Taenia solium (Cysticercus cellulosae)

Adult *Taenia solium* reach 3-5m in length. The scolex has an armed rostellum with two rows of hooks, followed by a strobila consisting of up to 1000 proglottids each with 7-16 uterine branches and measuring up to 10 mm in breadth at maturity. The oval cysticerci can be the largest of the three zoonotic *Taenia* spp., reaching approximate dimensions of $\geq 0.5 - 1 \times 0.5$ cm and have a scolex bearing a rostellum armed with hooks similar to that of the adult tapeworm (OIE, 2004).

Developmental stages of *Taenia solium* (Cysticercus cellulosae): Eggs passed in feces or discharged from ruptured gravid segments are sub spherical to spherical in shape. The egg consists of the hexacanth (6-hooked) embryo (oncosphere) thick dark brown to yellow in color. There is an outer oval membranous coat, the true eggshell, which is lost in fecal eggs. It measures 30-41 micrometers in diameter and 46 to 50 micrometers in length. The eggs survive up to 200 days in moist manure, 33 days in river water, 154 days on pasture and are resistant to moderate desiccation, disinfectants and low temperature (4-5 °C).

Life Cycle of the zoonotic *Taenia*: These tapeworms have an indirect life cycle and are relatively host specific for both larval and adult stages. Humans are the only natural definitive hosts of the adult tapeworm. The adult tapeworm is fully developed and reproductively mature as early as 10-12 weeks (depending on species) after infection of the host. Once mature, the tapeworm regularly sheds its most posterior segments, called gravid proglottids, which are discharged from infected humans spontaneously or with defecation. These proglottids contain thousands of immediately infective eggs that can remain in the proglottid or be expelled free into the surrounding fecal matrix or environment. On average, a single *T. saginata* tapeworm releases six to nine proglottids daily. Although multiple and mixed species

infections can occur, most taeniosis infections involve a single tapeworm. Upon ingestion by a suitable intermediate host, a hexacanth embryo, or oncosphere, hatches from the egg and uses its six hook lets to penetrate the intestinal mucosal within a few hours to enter the circulatory or lymphatic system. It eventually reaches the tissue site (such as the lymphatic space in skeletal muscle) where it eventually develops into a cysticercus which is infective to a human final host after about 10-12 weeks [9-11]. or as early as 4 weeks for *T. saginata* asiatica. The intermediate hosts for *T. saginata* and *T. saginata* asiatica cysticerci are *Taenia saginata* asiatica cysticerci localize primarily on the serosal surface and within the Parenchyma of the liver of pigs, and occasionally in extrahepatic peritoneal sites. Experimental infections have also been reported for cattle, goats and monkeys. The normal intermediate host of *T. solium* is domestic swine, although a variety of other species, including humans and dogs, can serve as intermediate hosts. The cysticerci localize in the tissues of the tongue, skeletal muscle (particularly thighs), subcutis, and central nervous system of pigs. Human consumption of infected pork or beef completes the cycle.

Epidemiology of Metacestods in Ethiopia Export Abattoir

In most countries, *T. saginata* is more common than *T. solium*. It is associated with areas of poor sanitation and high consumption of beef. Many of the cases seen in the United States are from immigrants who came from a country that has higher rates of beef tapeworm. The number of cases in the United States is much higher than that of *T. solium*. Eggs may remain viable in human feces for several weeks such that cattle who ingest them will become infected. *Taenia saginata* is distributed globally but the infection is particularly important in Africa, Latin America, and Asia as well as in some Mediterranean countries. The prevalence of *T. saginata* in humans can be roughly classified into three groups: highly endemic regions with prevalence that exceed 10%; those with moderate prevalence; and those with prevalence below 0.1% or free from *T. saginata* taeniosis. Highly endemic areas include Central and East African countries (Ethiopia, Kenya, and Zaire), Argentina, Caucasian and South-Central Asian republics of the former USSR and in the Mediterranean Region (Syria, Lebanon and Yugoslavia). In some parts of Serbia and Montenegro, up to 65% of children have been reported to harbor *T. saginata*. Moderate prevalence is encountered in South East Asia (Thailand, India, Vietnam and Philippines), Japan as well as countries of Western Europe and South America while Canada, the USA, Australia and some countries of the Western Pacific have low prevalence [12,13].

In developing countries, cattle are reared on extensive scale, human sanitation is of comparatively lower standards and the inhabitants traditionally eat raw or inadequately cooked beef.

The prevalence of Taeniasis is over 20% in certain areas of these countries. Based on routine carcass inspection the infection rate of bovine cysticercosis is often around 30-60% although, the real prevalence is considerably high. *T. saginata* infections also occur in developed countries, where standards of sanitation are high and meat is carefully inspected and generally thoroughly cooked. Taeniasis/cysticercosis spreads in developed areas of the world through tourists enjoying the consumption of lightly grilled meat, mass migration of labor and the export of meat unreliably passed by "eye or knife" inspection or from live animals imported from endemic areas. Prevalence in these parts of the world is less than 1%. Occasionally, however, cysticercosis "storms" have been reported on particular farms. The cause of the storm has been attributed to the use of human sewage on pasture and the use of migrant labor. In developed countries, cattle of any age, are susceptible to infection since they generally possess no acquired immunity.

Economic Impact and Risk Factors of Metacestods in Ethiopia Export Abattoir

Cystic echinococcosis (CE or hydatid disease) is a zoonotic infection caused by the larval stage of the taeniid tapeworm *Echinococcus granulosus*. The parasite's life cycle is maintained through dogs (which harbor the adult worm in their small intestine) and a range of domestic livestock that serve as intermediate hosts. *E. granulosus* eggs are excreted in the faeces of infected dogs and may thus contaminate soil, grass and water. Ungulates (hoofed animals) can become infected by grazing on pasture contaminated with dog faeces. Ingested eggs hatch inside the intestine, penetrate the gut wall and are carried by the bloodstream to different organs and tissues (mainly the liver and lungs) where they develop into cysts (metacestodes) that can eventually cause severe pathological damage. Humans can become infected by ingesting eggs through consuming contaminated food or water or from handling the faeces of infected dogs.

Veterinary world to estimate the annual economic losses from hydatidosis in cattle considering losses from cost of organ condemnation and from carcass weight. The retail market price of average size offal (lung, liver, kidney, heart and spleen) and the cost of one kg beef were obtained from information gathered from local butchers. Annual economic loss due to organ condemnation was determined by considering annual slaughter rate of cattle and prevalence of hydatidosis per organ and an estimated 5 % carcass weight loss was considered. Average carcass weight of Ethiopian local breed cattle is estimated as 108 kg. The total economic loss was calculated as the summation of cost of offal condemned plus the cost of carcass weight losses.

Conclusion and Recommendations

In conclusion, hydatidosis is prevalent and causes considerable economic loss in livestock production in Ethiopia export abattoir. Therefore, proper meat inspection and disposal

of condemned organs are essential to reduce the financial losses and safeguard the public. In addition to this, the construction of well-equipped abattoirs and enhancement of awareness of people about the economic and public health importance of the disease are also crucial. Our findings indicate that CE imposes a significant economic burden on Ethiopia export abattoir. They also emphasize the importance of maintaining or reinforcing current control measures to consolidate the progress achieved and to reduce human and animal infection rates. Further work is required to evaluate the cost-effectiveness and cost-benefit of any control programs implemented, and to guide decision makers and stakeholders on the best approach to take with the resources available. Better coverage and accuracy of the current surveillance systems are needed, as are improvements in the cooperation between the central and regional administrations, and the institutions responsible for collecting, providing and epidemiological relevance.

Conventional meat inspection technique, which is less sensitive, was practiced in the study area and the detection of bovine cysticercosis was influenced by minimized number of cuts in inspected predilection sites, lack of transportation facilities and lack of equipment's and level of qualification offered to the meat inspectors. By conventional meat inspection techniques infected carcasses can be easily missed and passed for human consumption thus favoring the infection transmission. Based up on the findings of the present study, the following points are recommended: -

- a. Infected meat and meat products must undergo the proper process of freezing, boiling or destruction based on the intensity of infection with cyticerci.
- b. Offal's found infected with the cyst must be properly disposed via through burying or incineration.
- c. Improve the working conditions of meat inspectors and up-grade their skills.
- d. Public awareness about the health and economic significance of the disease with special reference to the danger of consumption of either raw or undercooked meat and usage of latrines should be made.
- e. Detailed meat inspection is suggested.
- f. Further studies should be conducted in other neighboring administrative zones.

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