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Review on *Bovine Cysticercosis* and Public Health Importance

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Abstract: ***Cysticercosis is an important zoonotic disease that affects both human and animals in Ethiopia. Bovine cysticercosis is a parasitic infection of cattle caused by the larval stage (cysticercus) of the cestode*** **Taenia saginata.** ***It is a cosmopolitan disease occurring in industrialised as well as developing countries. However, its distribution is associated with economic conditions, religious beliefs and close proximity of humans to cattle in utility function. Humans are the definitive host and harbour the adult form of the parasite in their intestines. Terminal segments containing eggs are detached from the adult parasite and millions of eggs may be released daily to the environment and cattle acquire the infection through the ingestion of eggs. The parasite migrates to metabolically active muscles where it develops into cysticerci and humans get infected by consuming raw or undercooked meat containing infective cysticerci. In cattle, natural infections are normally asymptomatic but they cause financial losses to the cattle industry due to downgrading, condemnation, extra handling, refrigeration and transport of the infected carcasses. The prevalence of the disease both in human and animals is high and economically significant. Nowadays, since there are accustoms of eating raw meat, lack of knowledge about ways of disease transmission, backyard slaughtering of animals especially during holydays, ignorance incision of meat by meat inspectors and lack of sanitation can give a great favour for continual existence of the parasite within the human and animal population. Strict routine meat inspection of slaughtered animals should be carried out and there should be public awareness about the health and economic importance of the disease.***

Keywords: *Bovine cysticercosis, Taeniasis,* Taenia saginata

1.Introduction

IN worldwide about 2.4 million people are infected and 180 million are at risk of the infection. In Africa, the infection has been found to be a serious problem in humid and sub-humid zones. (Ekenma Kalu, 20150). Foods of animal origin are often the preferred source of protein. However, if not properly prepared or handled, they can lead to food-borne infections. *Cysticercosis* caused by *Taenia saginata* is among the diseases that affect food safety (Teklemariam, et al., 2015*). Taenia saginata cysticercosis* or *bovine cysticercosis*, caused by the metacestodes of *T. saginata*and it is one of the major parasitic diseases, which does not only lead to economic loses, but also adversely affect public health. It is a cosmopolitan disease occurring in industrialized as well as developing countries (Dorny *et al.2*002). However, its distribution is wider in developing countries, where hygienic conditions is poor and where the inhabitants traditionally consume raw or insufficiently cooked or sun cured meat (Larry, 2009).

In the life cycle, *T. saginata* has two different stages in which larval stage (Cysticercus bovis) occurs in heart and skeletal muscles of cattle as intermediate host and adult worm locates in intestine of human as final host (Garedaghi & Shabestari-Asl, 2012) (Garedaghi *et al.*, 2012). Humans are the definitive host and harbour the adult form of the parasite in their intestines. Terminal segments containing eggs are detached from the adult parasite and millions of eggs may be released daily to the environment. Cattle acquire the infection through the ingestion of eggs. The parasite migrates to metabolically active muscles where it develops into *cysticerci* and humans get infected by consuming raw or undercooked meat containing infective *cysticerci* [Laranjo-González et al., 2016]. In cattle, natural infections are normally asymptomatic but they cause financial losses to the cattle industry due to downgrading, condemnation, extra handling, refrigeration and transport of the infected carcasses (Boone et al., 2007; Hashemnia *et al.*, 2015).

Although *cysticercosis* in cattle often has no clinical features, however, heavy infection may cause *myocarditis*. Human infection that occurs through consuming of infected raw or semi-cooked beef may results in *epigastric* pains, diarrhea, nausea, weakness or loss of appetite (Lees et al., 2002). Furthermore, several studies have indicated that *taeniosis* or *bovine cysticercosis* is an important meat-borne *zoonosis* that affects the safety of food presented for human consumption in different areas of Ethiopia. The reported prevalence of *T. saginata taeniosis* in the human population in Ethiopia has been found to range from 31.0% to 89.4% [Negussie 2011]. The reported prevalence of bovine *cysticercosis* in cattle populations across various regions of Ethiopia was reported to range between 2.2% to 26.3% [Kumar andTadesse 2011].

A number of reports in Ethiopia indicated that, certain groups who had easy access to raw meat and meat products (Butchers and abattoir workers) and those people with low level of formal education were reported to be more infected with parasitic *zoonosis* than those who had low access to raw meat and those with better education. This implies that the frequency of raw beef consumption is higher in these groups of people [Nigatu*et al*., 2009; Adugna*et al*., 2012]. Despite both economic and public health significance of this disease there is scarcity of documented information.

Objective of this work:

- To provide the concise review on *bovine cysticercosis*
- To highlight public health and economic importance of *bovine cysticercosis*

2.Literature Review

2.1 Etiologyand Taxonomy

Bovine cysticercosis is a disease that affects the musculature of cattle and is caused by the metacestode stage of human intestinal *cestode, Taenia saginata* (Laranjo-González *et al.,* 2016). *Taenia saginata* and its *metacestode, Cysticercus bovis*, the unarmed beef tapeworm, is classified under the kingdom of *Animalia* (Figure 1). *Cysticercus bovis* is the larval stage of *Taenia saginata* of the small intestine of humans as a larvae or cysts in cattle (C. bovis), man acquires infection only by eating poorly cooked or raw beef (Laranjo-González *et al.,* 2016).

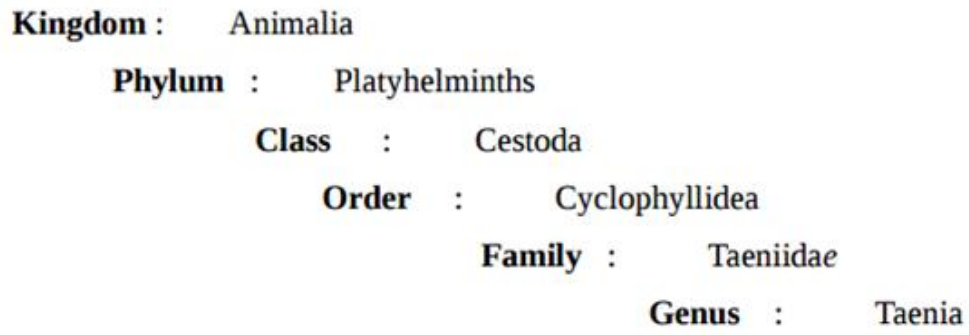

Figure 1: Taxonomic classification of taenia

Source: [Urquhart *et al.,* 1996]

Morphology of the adult tapeworm of *T. saginata* is a large ribbon shaped, multi segmented and white flat worm usually 4-15 m long consisting of thousands of segments (proglottids) arranged in a chain (Andrews et al., 2003). Its body divided in to three distinct parts consisting of head (scolex), neck and strobilla. The head or scolex bearing attachment organs, a short unfermented neck and chain of segments. The chain is known as strobilla and each segment as proglottids. Unlike other taeniids, the head (scolex) has no rostellum or hooks. The proglottids are continually budded from the neck region and become sexually mature as they pass down the strobilla. Each proglottid is hermaphrodite with one or two sets of reproductive organs. Gravid segments usually leave the host singly and often migrate spontaneously from the anus (Blancou *et al*., 2010).

Taeniid eggs passed in the stool or discharged from ruptured segments are sub-spherical to spherical in shape and very resistant, remaining viable for 6 months in pasture and vegetables, 5 weeks in water, 10 weeks in stool or hay and 12 weeks in silage sludge. *Taeniid* eggs measure about 30-45 µm in diameter; contain an *oncosphere* (hexacanth embryo) bearing three pairs of hook; have a thick, brown, radially striated embryophore or 'shell' composed of hooks; and there is an outer, oval, membranous coat, the true egg shell, that is lost from fecal eggs. The larval stage, or metacestode also referred to as "*beef measles*", are found in all striated muscles of the intermediate host. *Cysticercus bovis* is a small, pea-sized oval in shape translucent and contains a single white scolex that is morphologically similar to the scolex of the future adult tapeworm. They are contained in a thin, host-produced fibrous capsule (OIE, 2008).

2.2 Life Cycle

In the life cycle, *T. saginata* has two different stages in which larval stage (*Cysticercus bovis*) occurs in heart and skeletal muscles of cattle as intermediate host and adult worm locates in intestine of human as final host (Garedaghi *et al.,* 2012). *Bovine cysticercosis* refers to the infection of cattle, while the adult tapeworms in the human small intestine cause *taeniasis*. Cattle are infected after ingestion of feed or water containing the eggs expelled by the human faeces. Although *cysticercosis* in cattle often has no clinical features, however, heavy infection may cause *myocarditis*. Human infection that occurs through consuming of infected raw or semi-cooked beef, may results in *epigastric* pains, diarrhea, nausea, weakness or loss of appetite (Lees *et al.,* 2002). The life cycle and transmission of the parasite occurs most commonly in environments characterized by poor sanitation, primitive livestock husbandry practices, inadequate meat inspection management and control policies. Humans are the obligate final host and they become infected by ingesting infected meat that has been inadequately cooked or frozen. Most incidents arise in cattle as a result of direct exposure to proglottids shed from humans, but there have been some reports of large scale outbreaks resulting from sewage-contaminated feed or forage (Tesfaye *et al.,* 2012). The tapeworm occurs in the small intestine of humans, and although it is generally 4-8 meters long, it can reach 15 meters. Like all tapeworms, its scolex (head) attached to the bowel wall and it has up to 2000 body segments. Each segment contains up to 80, 000 eggs. The end segments of the tape worm detach and are passed with faeces, they look like white fleshy capsules similar to a grain of rice**.** If the eggs in the segments find their way onto pasture, cattle may ingest the eggs which then hatch in the small intestine. Small embryos develop and penetrate the bowel wall.

They are carried through the blood stream to various muscles where they develop into cysts, the muscles most commonly affected by *Cysticercus bovis* cysts are the heart, tongue, diaphragm and muscles of the jaw. The cysts may remain infective for up to 2 years (NSW, 2012).

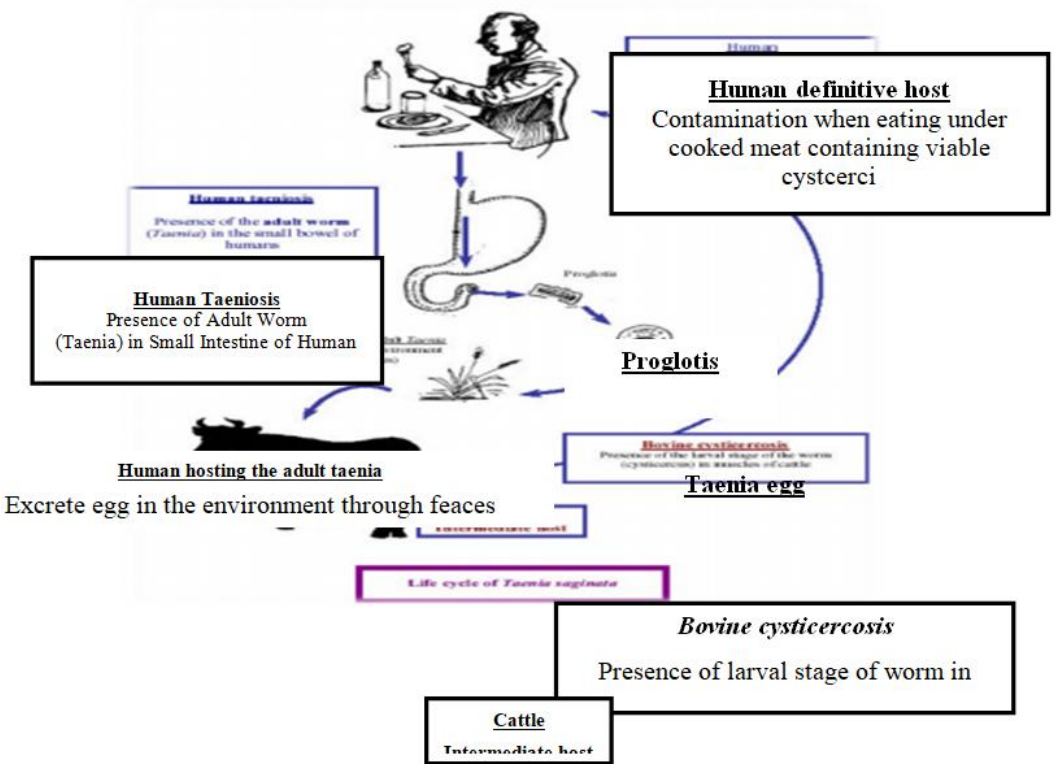

Figure 2: The Life cycle of Taenia saginata
Source: adopted from (European Commission, 2000)

3.Epidemiology

3.1 Distribution

Taenia saginata has worldwide distribution, albeit at a very low prevalence in the developed countries. The moderate prevalence level is seen in southern Asia, while African countries have the highest prevalence rates and the parasite causes an important economic loss due to condemnation of meat in these countries (Cabaret *et al.*, 2002). Globally, there are 77 million human carriers of *Taenia saginata* out of which about 40% live in Africa. In developed countries, even if the disease has a very low prevalence, the problem with the removal and treatment facilities in their sewage system plays a role in the distribution of eggs, since it was recorded that the egg can survive in sewage (Megersa *et al.*, 2010). In many developing countries this disease constitutes a serious but less recognized public health problem (Ibrahim and zerihun, 2012).

The disease has been reported in 15 Latin American countries, and it is estimated that 400 thousand people are infected in South America. However, the prevalence of this disease in humans is highly variable within a country and between countries, and can be directly related to the differences of hygienic conditions, quality of meat inspection, and culinary habits (Dutra *et al*, .2012). In Ethiopia, Florava reported a prevalence of 100% which is the highest in Africa and also in the word, due to habit of eating raw or under cocked beef dishes. In other East Africa countries, prevalence rate about (30-80%) has been reported (Ibrahim and zerihun., 2012).

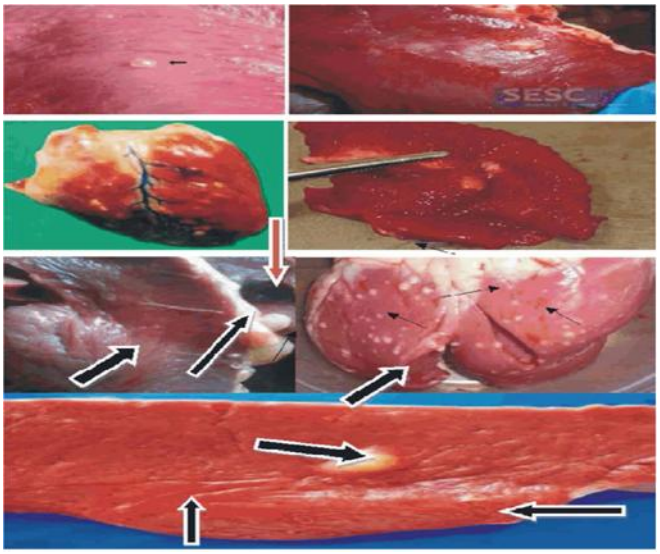

Figure 3: Cysticercus boviscyst distribution in different organs

3.2 Source of infection and tranismtion

Cattle, intermediate host, become infected after eating *Taenia saginata* eggs (proglottids) from infected humans (Final host). Once cattle are infected, cysticerci develop in the muscles and subsequently become infective to humans after approximately 10 weeks. A person infected with a

single *Taenia saginata* tapeworm is capable of contaminating the environment with up to half a million eggs per day over the course of Infection, which if left untreated, can persist for years. Eggs contaminating the environment via defecation or spontaneous discharge of proglottids can be disseminated by water, wind, scavenging birds such as gulls feeding on raw sewage, oribatid mites, flies, earth worms, or fomites such as boots or farm machinery (Kandil *et al.*, 2012).

Infective taenia eggs can persist under a variety of environmental conditions as with most parasite environmental stages, cool and moist conditions favor long-term survival. They can also survive in sewage and in sludge for up to several months, and are resistant to most conventional chemical and disinfecting agents (Kandil *et al.*, 2012). Transmission to animals occurs by contamination of food or water by faeces of infected humans. The contaminated material can derive directly from human faeces or via sewage plants after flooding or sewage sediment distributed on pastures. Direct transmission of eggs, resulting from hand rising of suckling calves by tapeworm carriers has been reported, but appears to be rare (Allepuz *et al.*, 2009). Lack of awareness about raw meat consumption, existence of highest population density, poor hygiene and sanitary facilities are some of the factors that facilitate the transmission (Belachew and Ibrahim, 2012).

3.3 Host range

Cattle are intermediate and humans are the finalhosts of T. saginata. In all age of cattle are susceptiblefor this parasite whereas young age groups are more susceptible than the others. Sometimes Parasitism is observed inother ruminants like sheep, goats, antelopes, gazelles and buffaloes, but the development of *Cysticercus* is unlikely to the others (Assefa, 2015). Man cannot spread *taeniasis* to his own species. Management of animals in their natural environment predisposes them to infection. Cattle grazing communally have a higher risk of picking up *T. saginata* eggs since they are frequently in contact with human feces compared to commercial herds, the risk of cattle coming into contact with *T. saginata* eggs is much higher when cattle are at pasture (Harrison and Sewell, 1991).

3.4 Risk factor

It was reported that several factors, such as activity of the muscles, age, and the geographical location determine largely the predilection sites for *C. bovisin* slaughtered cattle (Opara et al., 2006). 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 and Murrell, 2001). The prevalence of *Taeniasis* is associated with different risk factors. The potential risk factors of *Taeniasis* are the habit of raw meat consumption, age, sex, educational level, presence and usage of sanitary facilities especially toilets. Different scholars have controversies regarding to disease prevalence in association with such risk factors. There is higher prevalence of *Taeniasis* in those who consumes raw meat than those having cooked meat dishes but no significant variations were observed between sex and religion. Megersa *et al.* [2010] reported that Taeniasis has significant association with ages of individuals and indicating higher prevalence of infection in adult people. The possible suggestion is that adults' humans are associated with the habit of raw meat consumption than younger through consuming raw meat like Kurt which may be expensive for young individuals.

Hailu (2005) reported that there is highly significant variation among raw meat and cooked meat eaters, in which prevalence is high in those eating raw meat. But no significant variations were observed between age, sex and religion. Megersa *et al*. (2009) reported in such a way that *taeniasis* has significant association with ages of individuals, indicating higher prevalence of infection in adult people. The possible suggestion for this case is that adults has habit of raw meat consumption than younger, as young are not allowed to consume raw meat, and adults have income that afford in consuming raw meat like *Kurt* which may be expensive for young individuals. Abunna *et al*. (2008) reported *taeniasis* has significant association with sex. Prevalence is higher in males than females. This could be due to economic reasons and cultural practices in that males do not prepare their dish at home, rather consume at restaurants and butcheries.

4.Clinical Manifestations

4.1 In Humans

The clinical manifestations in humans include abdominal pain, nausea, debility, weight loss, flatulence and diarrhea or constipation. A patient may have one or several of these symptoms and a high percentage of patients experience gastric hyposecretion. Individual reactions to the infection differ and may be influenced by psychogenic factors, since patients often notice symptoms only after they see proglottids (Symth, 1994). Signs like those of epigastric discomfort, hunger sensations and irritability were also observed in infested individuals (Harrison and Sewell, 1991).

4.2 In Animals

Light or moderate c*ysticercosis* in cattle is not usually associated with any defined clinical picture. Heavy infections, those induced experimentally by 200, 000 to 1, 000, 000 *T. saginata* eggs, may give rise to fever, weakness, profuse salivation, anorexia, increase heart and respiratory rate and a dose of one million or more eggs may cause death between 14 to 16 days due to a degenerative myocarditis (Oryan *et al.*, 1998).

5.Status of *Bovine Cysticercosis* in Ethiopia

The cultural habit of eating raw meat in form of "Kourt" meat cubes and "Kitffo" minced meat in Ethiopia, has favoured the spread of this disease (Fufa, 2006). The reported prevalence of bovine cysticercosis in cattle populations across various regions of Ethiopia was

reported to range between 2.2% to 26.3% (Kumar and Tadesse, 2011).

Belachew and Ibrahim. (2012) conducted cross sectional study on the prevalence of bovine *cysticercosis* in Hawassa municipal abattoir from October 2011 to March 2012with the objectives of determining the prevalence of *Cysticercus bovis*, cyst viability and cyst distribution in different organs/tissues and public health implication of *Taenia saginata cysticercosis*. Questionnaire survey and inventory of pharmaceutical drug shops were also used to determine human taeniasis and associated financial losses. Ante and post mortem examination of 384 cattle at the abattoir showed a prevalence of 22.9% for cysticercosis. Of the total cysticerci collected, 55 (62.5%) were found to be viable while 33 (37.5%) were non-viable. The percentage of *Cysticercus bovis cysts* in different organs was observed as 67.74% in tongue, 52% in shoulder, 60% in heart and 75% in masseter muscle, respectively. Result indicated that only age groups are highly significant effect (p0.05) on prevalence of *cysticercosis*. The prevalence of *taeniasis* among interviewed respondents of Hawassa town was 44%. Result indicated that the sex, occupation, educational level, eating habit and marital status showed highly significant effect (p0.05) on prevalence of the disease. However, statistically significant difference was observed in the disease prevalence between raw and cooked meat eaters. For the years 2008 and 2009, a total worth of 184, 406 ETB was estimated from a sale of 92, 203 adult taenicidal drugs.

Another cross sectional study was conducted during November 2008 to March 2009 to estimate the prevalence of *Cysticercosis* in animals, *Taeniasis* in human and estimate the worth of taeniasis treatment in Jimma town, Ethiopia (Megersa *et al*., 2010). Active abattoir survey, questionnaire survey and inventory of pharmaceutical shops were performed to accomplish the study. Of the total of 500 inspected animals, 22 animals had varying number of *Cysticercus bovis* giving an overall prevalence of 4.4% (22/500). Anatomical distribution of the cyst showed that highest proportions of *Cysticercus bovis* cyst were observed in shoulder muscle, followed by tongue, heart and masseter muscle. Of the total of 114 *Cysticercus bovis* collected during the inspection, 49 (42.9%) were found to be a live while others (57.1%) were degenerative cyst. Of the total 60 interviewed respondents, 56.7% (34/60) had contracted T*aenia saginata (*Megersa *et al.*, 2010).

Tolosa *et al. (*2009) condiucted study to determine the prevalence of *bovine cysticercosis* from October 2007 to March 2008 in cattle slaughtered at the Jimma municipal abattoir. Cyst distribution and viability of *bovine cysticercosis* were determined. A total of 512 carcasses were inspected of which 15 (2.93%) were infected with *Taenia saginata metacestodes*. From a total of 109 cysticerci collected from infected carcasses, 47 (43.12 %) were viable. The anatomical distribution of the cysticerci was, shoulder muscle (39.5 %), heart (33.9 %), neck muscle (13.8 %), tongue (10.1 %), masseter muscles (1.8 %) and diaphragm (0.9 %).

In another study, post-mortem examination of 3711 cattle done at three municipal abattoirs at Mekelle, Wukro and Adigret in Tigray region for detecting infection of *Cysticercus bovis* revealed 308 (8.29%) cattle positive for this infection. The cysts were observed either at one or more than one sites in the carcass with variable numbers. The sites showing cysts included tongue 0.61%, masseter muscles 0.59%, shoulder muscles 0.26%, heart 0.26% and liver 7.45% (Kumar and Berhe., 2008).

Teklemariam *et al., (*2015) studied *bovine cysticercosis* from December 2014 to April 2015 on 384 zebu cattle slaughtered at Batu municipal abattoir to estimate the prevalence and associated risk factors. Out of 384 inspected animals, 10 animals had variable number of *Cysticercus bovis* giving an overall prevalence of 2.6%. Anatomical distribution of the cyst showed that the highest proportions of *Cysticercus bovis* cyst were observed in tongue 10 (41.66%) followed by heart 7 (29.17%), masseter 5 (20.83%) and triceps muscle 2 (8.33%).

Table 1: Status of Bovine Cysticercosis in Ethiopia

Location	Prevalence in %	
Batu municipal abattoir	2.6	Teklemariam et al., 2015
Jimma municipal abattoir	2.93	Tolosa et al. 2009
Hawassa municipal abattoir	22.9	Belachew and Ibrahim.2012
Jimma	4.4	Megersa et al. 2010
Awassa	26.25	Abunna et al. 2008
Awassa	30	Fikire, 2012
Central Ethiopia	3.1	Tembo, 2001
East Shoa	17.5	Hailu, 2005
Gonder meat factory	9.7	Amsalu, 1989
Gonder	4.9	Dawit, 2004
Luna export abattoir in East Showa	27.6	Hailu, 2005
Nekemte	2	Ahmad, 1990
North westen Ethiopia	18.49	Negatu, 2008
Tigray	21	Berhe, 2009
Wolaita Soddo (Southern Ethiopia)	11.3	Regassa et al., 2009

6.Diagnosis

6.1 Meat inspection

Diagnosis in animals is usually based on the host and the location of the *metacestode* when identified at meat inspection or necropsy. Adults in definitive hosts are acquired by the ingestion of viable metacestodes in meat and offal that has not been adequately cooked or frozen to kill the parasite. In live animals *Taenia saginata metacestode* might be palpable in the tongue but, both in the living animal and on post-mortem examination or meat Inspection, tongue palpation is of diagnostic value only in cattle heavily infected with metacestode (Wubie, 2004). Predilection sites are heart, tongue, masseters and diaphragm, presumably because they receive the greatest circulation. Nonetheless, cysts may be found in any muscle of the body (OIE, 2008). Cattle with *cysticercosis* are unlikely to exhibit clinical signs, and detection is made during post-mortem carcass examination. In most parts of

the world where regulated post-mortem screening for these parasites occurs, examination of so-called "predilection sites" is conducted during routine meat inspection. However, such procedures are insensitive, particularly for lightly infected carcasses. Despite its limitations, visual inspection of carcasses remains the most common method of diagnosing *bovine cysticercosis*. The metacestode are readily visible in the organs or musculature at autopsy and therefore diagnosis of *bovine cysticercosis* usually made during postmortem examination in abattoirs and packing plants. The effectiveness of meat inspection in the detection of *C. bovis*depends on the procedure used (Wubie, 2004). According to Meat Inspection Regulation Notice Number 428, 1972 by Government of Ethiopia (MoA, 1972), the routine inspection of carcass is to be done as per the procedure stated below

- ✓ Visual inspection and palpation of the surfaces and a longitudinal ventral incision of the tongue from the tip of the root.
- ✓ One deep incision into the triceps muscles of both sides of the shoulder.
- ✓ Extensive deep incision into external and internal muscles of masseter parallel to the plane of the jaw.
- ✓ Visual inspection and longitudinal incision of the myocardium from the base to the apex. But more incision can be made when necessary.
- ✓ Visual inspection and 3 parallel incisions into long axes of the neck muscles on both sides.
- ✓ Two parallel incisions on the thigh muscles of both hind legs.
- ✓ Careful inspection, palpation and two parallel incisions into the diaphragmatic lobes of the lung through the lung substances.
- ✓ Visual examination of intercostals muscles and incisions when necessary.
- ✓ One extensive incision into the fleshy part of diaphragm, visual examination, palpation and Incision of kidneys, liver, oesophagus and associated lymph nodes

However, minor infections are difficult to detect irrespective of the skill of the inspector. If a Cysticercus is found in any ofthese sites and organs, thorough inspection of the whole carcass and offal should be done. The location, nature and number of cysts should be recorded (Kumar and Tadesse, 2011).

6.2 Detection of antibodies by ELISA

Serological test, e. g., Enzyme-linked Immunosorbent Assay (ELISA) was available for use on live animals. The immune response against taeniid parasites is reported to be antibody-mediated. A positive antibody ELISA indicates that the animals have been exposed to the infection, but may not necessarily have a current infection. However, it is a useful method for epidemiological studies to indicate the spread of the infection in outbreaks or high-infected areas (Kandil et al., 2012). Several studies have shown that the true prevalence of bovine cysticercosis as detected by the classical meat inspection techniques (carried out properly) is underestimated by at least a factor of 3-10, diagnosis by serology in cattle has been done with varying successes. Studies have indicated that antigen detection by ELISA (Ag-ELISA) is 2-10 times more sensitive than routine meat inspection and that this technique may therefore be recommended for epidemiological surveys. The sensitivity of Ag-ELISA has been shown to vary with the live cyst burden, in addition due to its unexplained false positive and negative reactions it can at best be used as a screening test and not as a diagnostic test (Asaava *et al.,* 2009).

7.Differential Diagnosis

In cattle *Cysticercus bovis* should be differentiated from the following parasites.

7.1 *Cysticercus dromedaries (C. cameli)*

The identification of *C. cameli* by double row of hooks on the lateral invaginatedscolex and its length being twice as large as *C. bovis*measuring 12-18 mm in length and pearly white in color (Wubie.2004).

7.2 *Sarcocystis bovi felis (Sarcocystis hirusta)*

Is a soft *bradizoite* cyst which is very large and visible to the naked eye whitish streaks running in the direction of the muscle fibers. The cyst ranges from 0.5 mm to 5mm in length, localized in the esophagus, heart, in different muscular tissue [Minozzo *et al.,* 2002].

7.3 *Onchocerca dukei*

The cyst ranges from3mm to 6mm in diameter, forms intra-muscular and subcutaneous nodules that are firm to touch and reveals worms surrounded by pus when sectioned (Wubie., 2004).

8.Control and Prevention

Lack of and improper use of latrine or open field defecation leads to contamination of grazing lands. The use of latrine reduces spread of Taenia saginata eggs. Controlled grazing, avoiding use of sewage effluent to fertilize pasture, prevents infection in cattle (Symth.1994). Adequate meat inspection, abstinence from eating raw or inadequately cooked beef (thorough cooking of meat at a temperature of 56 - 60 0_C) and freezing the infected carcass at-100 c for 10 days prevent human infection. Chemotherapy in humans reduces the spread of eggs and infection in cattle (Solusby.1982). In Africa, inadequate health education and scarcity of Taenicides are the major obstacles for the control of the disease (Rabi'u *et al.,* 2010).

The inspection of meat, which is the most important public health control measure, identifies only a minor fraction of heavily infected animals, and also only when it is too late to avoid losses. Ante-mortem diagnostic test that reflects the number of live *cysticerci* would be desirable because as it could assist in identifying infected animals before slaughter. A reliable ante-mortem diagnostic test has yet to be defined. However, there have

been endeavor to develop an enzyme-linked immune sorbent assay (ELISA) that can be used for the diagnosis of *Taenia Saginata Cysticercosis* infection under natural and controlled conditions. Results from antibody-ELISA were found to be unreliable and insensitive due to failure of the test to distinguish between animals harboring live and dead *cysticerci* (Wanzalaa *et al.*, 2002).

During meat inspection heavily infected carcass, all meat, offal and blood must be condemned. The description of a heavy infection varies, but generally it is the detection of cysts at two of the predilection sites plus two sites in the legs. In the case of a lesser infection, the infected parts and surrounding tissues are removed and condemned. Even a single dead cyst requires that the carcass and edible viscera must then be treated and this is justifiable as about 10% of lightly infected carcasses were found on dissection to have both dead and viable parasites within them (OIE 2008). Treatment varies with country and facilities available and includes (OIE 2008):

- ✓ Freezing at lower than - 10°C for 10 or 14 days, or lower than - 7°C for 21 days.
- ✓ Boxes of boned meat are frozen at less than - 10°C for 20 days.
- ✓ Heated to above 60°C throughout.
- ✓ Steamed at moderate pressure (0.49 kg/cm2), heated at 95-100°C for 30 minutes.
- ✓ Pickled in salt solution for 21 days at 8-12°C

Vaccination, when available, is undoubtedly the most cost effective means of preventing and controlling, and even eradicating, infectious diseases. A vaccine against sheep *cysticercosis* has been developed experimentally and may lead to the development of similar vaccines to control *bovine cysticercosis* and thus *Taenia saginata* infestation in humans. Rickard and Adolph, (1976) vaccinated calves with antigens collected during cultivation of the larval stages of *Taenia saginata*. In-vitro, and challenged 4 weeks later with 4, 000 *Taenia saginata*eggs. Calves vaccinated with *Taenia saginata* antigen were highly resistant to the challenge infection. Sheiba and Zein Eldin, (1987) vaccinated four Zebu calves subcutaneously with hatched ova of *Taenia saginata*. The immunity elicited protected the animals from subsequent oral infections with this cestode as manifested by the early degeneration of the *metacestodes* and failure to attain maturity in three of four animals. Lightowlers *et al., (*1996) used the recombinant antigens in vaccine trials in cattle. Vaccination with a combination of two antigens, designated TSA-9 and TSA-18, induced up to 99.8% protection against experimental challenge infection with Taenia saginata eggs.

9.Treatment

The drug of choice in treating *Taeniasis* is *niclosamide* (Niclocide, Yomesan). Adult dose rate of 2000 mg is effective in damaging the worm to such an extent that a purge following therapy often produces the scolex. *Praziquantel* (Bilitricide) at a dose rate of 5 to 10 mg per kg also has been reported highly effective (Doyle *et al.*, 1997) but the scolex is partially digested and often not recovered (Symth, 1994). Other drugs used in the treatment of *T. saginata* are *mebendazole (*Doyle *et al.*, 1997).

In animals, treatment with compounds such as *albendazole* (50mg per kg), *praziquatel* (50mg per kg), *mebendazole* (50mg per kg) can be given but they are considered not to be fully effective. *Praziquantel* is effective at 50mg / kg / day for four days but this treatment is impractical because of its high cost (Symth, 1994; DestaWubie., 2004). In Ethiopia people used traditional medicaments to cure from *T. saginata* infection. Ahmed, (1990) reported that most people, especially rural inhabitants use different types of traditional herbal drugs to routine self-de worming practices.

10. Economic Importance

Bovine Cysticercosis has little effect on animal health, but it is economically important disease as it causes carcass condemnation arising from heavy infestation with the *cysticerci*of *Taenia saginata* as well as the cost of inspecting meat, the necessity to freeze or boil infected meat and losses may also occur from restriction of exports of live animals and animal products (Belachew and Ibrahim., 2012). Evaluation of the economic impact of *taeniasis / cysticercosis* is very difficult particularly in developing countries like Ethiopia, where necessary information is so scant and considerable proportions of infected people treat themselves with traditional herbal drugs like “kosso” and others. (Abuna*et al.*, 2007). While ill-health caused by the adult worms in humans gives rise to high medical costs, the economic losses due to bovine *cysticercosis* are mainly due to condemnation, treating beef and downgrading of infected carcasses. Economic losses from *cysticercosis* are determined by disease prevalence, grade of animals infested, potential markets, prices of cattle and treatment costs for detained carcasses. For the African continent, an annual loss was reported to be US$ 1.8 billion under an overall infestation rate of 7% (Kumar and Tadesse, 2011). Khaniki *et al., (*2010) reported that the economic losses of infected carcasses were calculated from the treatment of carcasses and the carcasses condemnations. The costs of carcasses treatment included the expenses of freeze storage and the weight loss during freezing.

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 (Nunes, 2003). In the meat industry, economic losses are closely associated with the status of infection. In a heavy infestation or generalized *cysticercosis* carcass must be totally condemned. Light infection or localized *cysticercosis* leads to condemnation of the infected parts, furthermore, the carcass must be kept in cold storage at a temperature not exceeding-7°C for up to 3 weeks to inactivate existing parasites (Abuseir *et al.*, 2006). In Ethiopia Megersa *et al. (*2010) revealed a total of 103, 596 adult *taeniacidal* drug doses worthing a total of 222, 706 Eth. Birr (22, 270.6 USD) during two years of 2007 and 2008. The economic

loss calculated for six months period of study by Kumar and Berhe. (2008) due to condemnation of carcass/organs account about 31952 Birr.

11. Public Health Significance

Cysticercus bovisis of great public health significance especially in developing countries where it invades the tissues of the eye as well as brain and spinal cord causing ocular and neuro*cysticercosis* respectively (Engels *et al*., 2003). A number of reports in Ethiopia indicated that, certain groups who had easy access to raw meat and meat products (Butchers and abattoir workers) and those people with low level of formal education were reported to be more infected with parasitic *zoonosis* than those who had low access to raw meat and those with better education. This implies that the frequency of raw beef consumption is higher in these groups of people (Nigatu*et al*., 2009; Adugna*et al*., 2012). The tongue, masseter muscles, cardiac muscles, triceps muscles and thigh muscles are the main predilection sites of the cysts. The cysts of *bovine cysticercosis* can alsobe identified on the spleen, intercostal muscles, diaphragm and liver (Garedaghi *et al.,* 2011).

Sometimes the gravid proglottids of Taenia saginata migrate to different organs appendix, pancreatic duct, nasopharyngeal pathways and bile ducts producing obstruction and inflammation of the affected organs (Florova, 1982). Tapeworms can also cause intestinal obstruction (Doyle *et al.,* 1997). The most noticeable symptom is the spontaneous discharge of one or several proglottids, which often show individual muscular activity. These may creep out of the anus onto the perianal skin and even migrate over clothes of the distraught host or on the ground, shedding eggs as they go (Oryan et al., 1998). *Taenia saginata* in the small intestine of man absorbs digested food (Kebede *et al.,* 2009). From the day the cysticercus is ingested it may take 2-3 months for the parasite to produce ripe segments. As long as the scolices are attached to the intestinal mucosa of the victim new segments will continually grow to replace those, which are being detached from the worm (Teka, 1997). Generally, according to WHO (2013), adult *Taenia* parasites located in the intestinal tracts of people can pose a variety of problems including:

- ✓ Non-specific intestinal disturbances-tapeworms can produce some non-specific signs of intestinal discomfort and pain (e. g. colic signs) in humans. Vomiting may also result.
- ✓ Non-specific appetite changes-tapeworms can cause some people to go off their food or to become fussy or picky about their eating habits (this appetite loss is possibly the result of such factors as abdominal pain and nausea). In contrast, certain other individuals develop a ravenous appetite in the face of heavy tapeworm infestations because they are competing with the parasite/s for nutrients (they need to physically eat more to provide enough nutrition for both themselves and the worms).
- ✓ Body weakness, headaches, dizziness, irritability and delirium.
- ✓ Malnutrition-very large numbers of adult *Taenia* tapeworms present in the intestinal tracts of man can result in the mal-absorption of nutrients. This can cause the tapeworm-parasitized individual to not receive the nutrition it needs (i. e. to not absorb its food properly), resulting in malnourishment, weight loss, ill-thrift and poor growth.
- ✓ Poor hair quality-severe malnutrition and mal-absorption of vitamins, minerals and proteins can result in reduced quality of the hair.
- ✓ Intestinal irritation-when an adult tapeworm inhabits the small intestine of human, it finds a suitable site along the lining of the intestinal lumen and grasps on to it using suckers. This spiky tapeworm grip is irritating to the wall of the small intestine, creating discomfort for the host and alterations in intestinal motility. Note that *T. saginata*, sometimes called the 'unarmed tapeworm', lacks a spiny rostellum so is not quite so damaging to the human intestine.
- ✓ Intestinal blockage-it is possible for massive tapeworm infestations to block up the intestines of children, producing signs of intestinal obstruction (e. g. vomiting, shock and even death). This is not common, but it can occur if worm burdens are large and/or if someone deworms the infested children, killing all of the worms in one hit (the tapeworms all die and let go of their intestinal attachments at the same time, resulting in a vast mass of deceased tapeworms flowing down the intestinal tract all at once and causing blockage).
- ✓ Intestinal perforation-rarely, adult *Taenia saginata* can perforate the intestinal wall, ending up inside of the host's abdominal cavity. This can result in life-threatening abdominal inflammation and infection and septicemia.
- ✓ Appendicitis, biliary obstruction, and pancreatitis-rarely, adult *Taenia saginata* (beef tapeworms) can migrate up into the duct systems of the pancreas and biliary tract (bile duct), producing blockages and painful inflammation of these regions. Some may even enter the appendix and cecum, causing nasty inflammation of these regions (termed appendicitis and typhlitis respectively). This can result in life-threatening complications that may require surgical correction.
- ✓ Perineal or anal irritation-the migration of tapeworm segments from the anuses of infested individuals can result in itching and irritation of the anus.

12. Conclusion and Recommendations

Bovine cysticercosis is one of the most important parasitic diseases caused by the metacestode stage of the human tapeworm *Taenia saginata*. The public health and economic consequences of this parasite may be considerable due to downgrading and the condemnation of carcasses. The adult stage of *Taenia saginata* occurs in the small intestine of humans who are the final host of this tapeworm. Humans get infected by eating raw or under cooked meat containing viable *cysticerci*. Nowadays, since there are accustoms of eating raw meat, lack of knowledge about ways of disease transmission, backyard slaughtering of animals especially during holydays, ignorance incision of meat by meat inspectors and lack of sanitation can give a great favour for continual existence

of the parasite within the human and animal population. Based on the above conclusion the following recommendations are forw (N. K, 2004).

- ✓ Avoid eating of raw meat (*Kurt*, *leble*and *kitffo*) that is not inspected by well experienced meat inspector.
- ✓ Further researches should be conducted on the epidemiology and control strategies of cestodes.
- ✓ Infected meat and meat products must be undergoing the processes of freezing and boiling.
- ✓ Strict routine meat inspection of slaughtered animals should be carried out.
- ✓ The community should use latrines to improve personal as well as environmental hygiene.
- ✓ There should be public awareness about the health and economic importance of the disease through social and public media.
- ✓ There should be strong and close collaboration between medical and veterinary professionals to reduce impact of the disease both in humans and animals.
- ✓ Untreated human feces should not be used as fertilizers.
- ✓ Competent meat inspection must be strictly implemented at every abattoir of the country.
- ✓ Immunodiagnostics must be developed to supplement meat inspection procedures.

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