Acta Parasitologica Globalis 8 (2): 101-109, 2017
ISSN 2079-2018

DOI: 10.5829/idosi.apg.2017.101.109

Zoonotic and Economic Impacts of Bovine Cysticercosis

Tolera Tagesu

Jimma University, School of Veterinary Medicine, Jimma, Ethiopia

Astract: *Bovine cysticercosis* is a zoonotic disease that affects the musculature of cattle and is caused by the metacestode stage of human intestinal cestode, *Taenia saginata*. It is a worldwide zoonotic disease affecting people and cattle, caused by the tapeworm *Taenia saginata*. It is cosmopolitan in its distribution and occurs in developing as well as in developed countries. Distribution is associated with economic conditions, religious beliefs and close proximity of humans to cattle in utility function. Humans are the definitive (mandatory) host for the tapeworm and cattle are the most common intermediate host. Cattle become infected when they ingest eggs that were shed in human feces. The eggs adhere to grass and other vegetation, where they can survive for several weeks to months. Once ingested by cattle, they develop into larvae and migrate to muscle tissue, most commonly the heart or around the jaw, diaphragm and tongue. Each larvae forms a fluid cyst surrounded by a fibrous capsule, know as a cysticerci or *Cysticercus bovis*. The presence of cysticerci in muscle is commonly referred to as "beef measles. Then human infected by eating of the infected beef muscle. Cysts of *C. bovis* is found anywhere in the carcass and viscera especially masseter, tongue, heart, triceps, inter costal muscles and the diaphragm are the most affected organs. The custom of eating raw or undercooked beef dishes such as *kourt*, *lebleb*, *kitffo* and the habit of defecating in open fields coupled with the tradition of allowing cattle to graze in such fields made *taeniasis* of human and *cysticercosis* of cattle common in developing countries. Its life cycle is indirect and entirely dependent on the link between man and cattle; so that any break in this link can result in the total elimination of the parasite. The disease has both public and economic importance by causing organ condemnation and cause economic loss by quality down grading of meat, cost of refrigeration, cost of human therapy and lowering productivity. The prevalence of the disease both in human and animals is high. *Taenia saginata* in small intestine of humans absorbs digested food and its proglottids migrate to different organs causing different signs. Economic loss from *cysticercosis* is determined by disease prevalence, grade of animals affected, potential market policy of cattle and treatment cost for detained carcasses. Therefore, the objective of this review is to provide an overview on the zoonotic and economic impacts of *Bovine cysticercosis* in animals and humans and also to highlight control and prevention strategies of the disease.

Key words: Bovine cysticercosis · *Taenia saginata* · Zoonotic/ Economic impacts · *Cysticercus bovis*

INTRODUCTION

Bovine cysicercosis is a disease that affects the muscle of cattle and is caused by the metacestode stage, of the human intestinal cestode, *Taenia saginata*. *Taenia saginata* and its metacestode, *Cysticercus bovis*, the unarmed beef tapeworm, is classified under the kingdom of *Animalia*, phylum of *Platyhelminthes*, class of *Cestode*, order of *Cyclophylidea*, family of *Taeniidae*, genus of *Taenia* and species of *T. saginata* [1, 2]. *Taenia saginata* is a worldwide zoonotic cestode whose epidemiology is ethnically and culturally determined with estimation of 50-77 million cases of worldwide annually. 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 [3]. Of zoonotic diseases, *bovine cysticercosis* is the disease that remains a major public health problem in lower income and some industrialized countries [4]. Both adult and larval forms hazardously affect health of their respective hosts, either directly or indirectly accompanied with several

Corresponding Author: Tolera Tagesu, Jimma University, School of Veterinary Medicine, P.O. Box. 307, Jimma, Ethiopia. Tel: +251917590810, E-mail: toleratagesu3@gmail.com; toleratagesu@yahoo.com.

secondary infections, particularly in human. The occurrence of larvae (*Cysticercus bovis*) in cattle musculature causes *bovine cysticercosis* while the adult worms in human small intestine cause taeniasis [5, 6]. Its life cycle is entirely dependent on the link between man (as definitive host) and cattle (as intermediate host); so, that any break in this link can result in the total elimination of the parasite. Cysts of *C. bovis* can be found anywhere in the carcass and viscera, but its illustrated sites are predilection like masseter, tongue, heart, triceps, intercostals muscle and the diaphragm which organs are consumed at raw level and causes of public health hazardous except heart of animals' [7]. The occurrence of the larvae of *T. saginata* in cattle musculature causes *T. saginata cysticercosis* or bovine *cysticercosis* while the adult worms in human small intestines cause taeniasis [8, 9]. Transmission of the parasite occurs most commonly in areas characterized by poor hygiene, primitive livestock husbandry practice and inadequate meat inspection, management and control policy. *Bovine cysticercosis* and *taeniasis* are common where hygienic conditions are poor and the inhabitants traditionally eat raw or insufficiently cooked or sun-cured meat [6]. Cattle are infected after ingestion of feed or water containing the eggs expelled by the human feces. Although cysticercosis in cattle often has no clinical features, however, heavy infection may cause myocarditis. Heavy infection of *T. saginata* results in weight loss, dizziness, abdominal pain, diarrhea, headaches, nausea, constipation or chronic indigestion and loss of appetite. There can be intestinal obstruction in humans and this can be alleviated by surgery. The tapeworm can also expel antigens that can cause an allergic reaction in the individual. Rarely it also causes pancreatitis, cholecystitis and cholangitis. FAO. [10] states that the disease can also cause obstruction of the bowel, stomach-ache and migrating proglottids cause inflammation of the appendix, inflammation of the bile duct, unpleasant surprise when seen in the feces. *Bovine Cysticercosis* affects both the health of the consumer and more significantly the country's economy, which approaches 30% if allowance is made for the loss in the carcass weight and the cost of freezing of the infected meat [11]. About 100 million people worldwide may be infected with either *T. saginata* or *T. solium* [12]. In Africa, inadequate health education and low availability of taenicides are the major obstacles for the control of the disease [1]. Therefore, the objective of this review is to provide an overview on the zoonotic and economic impacts of *Bovine cysticercosis* in animals and humans and also to highlight control and prevention strategies of the disease.

Etiology: Bovine cysticercosis refers to the infection of cattle with metacestodes of human tapeworm while the adult tapeworms in human small intestine cause taeniasis [13, 14]. The definitive host of *T. saginata* (beef tape worm) is humans, intermediate host is cattle and Metacestodeis Cysticercus bovis.

Taxonomical Classification

Binomial name: Taenia saginata

Kingdom	Animalia
Phylum	Platyhelminthes
Class	Cestodes
Order	Cyclophyllidea
Family	Taeniidae
Genus	Taenia
Subgenus	Taenia rhynchus
Species	Saginata
Metacestode	Cysticercus bovis

Source [1, 2, 15]

Morphological Identification: The adult tapeworm, *T. saginata*, is a large ribbon shaped, multi segmented, white flat worm usually 4-15 m long consisting of thousands of segments (proglottids) arranged in a chain [2, 16]. Its body divided in to three distinct parts consisting of head (scolex), neck and strobilla (Chain of proglottids) [17]. The head or scolex bearing attachment organs, a short unsegmented neck and chain of segments. The chain is known as strobilla and each segment as proglottids. Unlike other taeniids, the head 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 proglottids is hermaphrodite with one or two sets of reproductive organs. Gravid segments usually leave the host singly and often migrate spontaneously from the anus [15, 18]. Eggs are either expelled from proglottid or released when it disintegrates. In the bovine, the mature cysticercus, *C. bovis* is grayish-white, about one centimeter diameter and filled with fluid in which the scolex is usually clearly visible. As in the adult *T. saginata*, it has neither rostellum nor hooks [19]. 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 [15]. The process of strobillization starts at the distal part of the neck. 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 egg shell, which is lost in fecal eggs [2, 15]. The larval stage/or metacestode is referred to as beef measles and found in all striated muscles of the intermediate of the host. *Cysticercus bovis* is a small, pea-sized and oval in shape [20], translucent and contains a single white scolex and morphologically similar to the scolex of the future adult tapeworm consisted with a thin, host-produced fibrous capsule [1].

General recognition features of *T. saginata* are:

- Large worm, segmented into chains called proglottids,
- Its about 6 to 7 millimeters in width, can be 10 meters long though usually 2-5 meters,
- Comprises about 1000-2000 proglottids (1 cm long) with 1/3 –1/2 being gravid,
- Proglottids have 15-20 lateral branches from the uterus and a lateral genital pore,
- Scolex has 4 suckers with a slight apical depression and no hook lets,
- No rostellum,
- No hooks,
- And the intermediate stage is *Cysticercusbovis* (*C. bovis*),
- Unarmed tapeworm

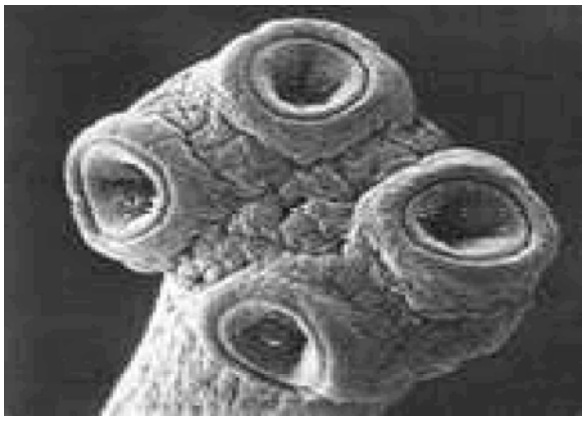

Fig. 1: *Taenia saginata:* It indicates absence of hooks and rostellum

Epidemiology: Distribution of *T. saginata* is worldwide [21- 23]. It has increased prevalence in Sub-Saharan Africa [22], Central and South America, Asia and some European countries [24]. High prevalence is associated with the habit of heating raw or undercooked beef [22]. High prevalence of *T. saginata*/*Cysticercusbovis* occurs in Africa where cattle are kept in community grazing lands. The parasites appear to be specific to cattle, while wild animals play no part as intermediate hosts. *T. saginata* is distributed worldwide, where cattle are raised and beef is eaten as raw or under cooked. It is very common in Ethiopia [19]. In Ethiopia, 2.2-3.2% of cattle are infected with larval stage of T. saginata, although the reported rates of infection in humans vary widely.

Host Range: Cattle are intermediate and humans are the final hosts of *T. saginata* [25]. Sometimes parasitism is observed in other ruminants like sheep, goats, antelopes, gazelles and buffaloes, but the development of Cysticercus is unlikely to the others [26]. Cattle of all ages are susceptible; however young age groups are more susceptible than the others. 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 [27].

Risk Factors of Taeniasis: 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, religion, educational level, presence and usage of sanitary facilities especially toilets. Different scholars have controversies regarding to disease prevalence in association with such risk factors. Hailu D., [28] 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. In contrast, Megersa *et al*. [29] 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. Most researchers underline that there is higher prevalence of *taeniasis* in those who consumes raw meat than those having cooked meat dishes [29- 31].

Distribution of Metacestode in Different Organs: The metacestodes were found throughout the edible parts of the carcass which includes masseter muscles, cardiac muscles, triceps muscles, thigh muscles, shoulder muscles, diaphragm, intercostal muscles, liver, heart, tongue, lung and kidney [20, 29, 30, 32].

Source of Infection and Mode of Transmission: As man is the source of parasites, human habits are responsible for the spread of *bovine cysticercosis*. In areas with trance human or nomadic systems, these habits are conditioned by the way of life and animals are exposed to infected feces. Infection of cattle is associated with directly to the non-hygienic disposal of stool by infected humans or indirectly by the use of human sewage on pasture as fertilizer [33]. The intermediate host will contract T. saginata by ingesting the eggs [24, 25]. The eggs develop into the infective cysticercus in the tissues of the infected intermediate host. Humans contract T. saginata by ingesting the cysticercus from the infected flesh of raw or undercooked beef.

Life Cycle: The life cycle of *T. saginata* is indirect where the definitive host is human and intermediate hosts are cattle [20]. Typically, the tapeworm life cycle consists of an adult tapeworm in the final host (i.e. human). The worms produce segments (proglottids) containing a considerable number of eggs which are shed on defecation. *Taenia* eggs containing an embryo (or oncosphere) are spread into the environment through sewage and may be orally ingested by the intermediate hosts (i.e. cattle). In cattle, the embryo move from the intestine to striated musculature. Here they develop into small vesicles called *cysticerci* containing one protoscolex, head of the future adult tapeworm [33]. The metacestodes were found throughout the edible parts of the carcass which includes masseter muscles, cardiac muscles, triceps muscles, thigh muscles, shoulder muscles, diaphragm, intercostal muscles, liver, heart, tongue, lung and kidney. The tongue, masseter muscles, heart muscles, triceps muscles and thigh muscles are the main predilection sites of the cysts. If man consumes these muscles containing viable *cysticerci*, a tapeworm may develop. Once viable *Cysticercus* can be sufficient, although immunity of the host can alter that. Prevention of human taeniasis and *bovine cysticercosis* is achieved by interrupting the life cycle of the parasite [34].

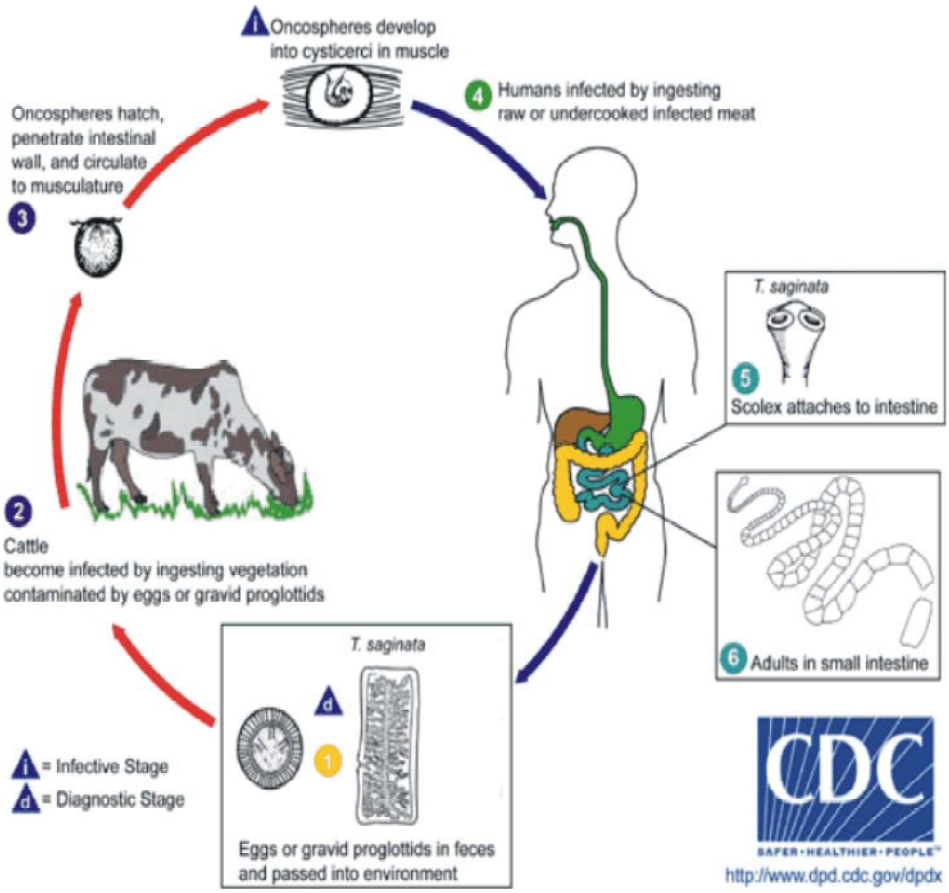

Fig. 2: Life cycle of *T. saginata*

Pathogenesis and Clinical Manifestation

Disease in Human: *Taenia saginata* is a tapeworm that can infect people if they eat undercooked beef containing viable tapeworm worm cysts. Human *taeniasis* is generally asymptomatic or manifested as mild non-specific gastrointestinal illness including symptoms of abdominal pain, digestive disturbance, nausea, diarrhea and anorexia [4]. The tapeworm utilizes nutrition of man thus causing great loss of nutrient in the hosts. Presence of large number of *T. saginata* causes enteritis [35].

Disease in Cattle: Cattle can become infected with the parasite by ingesting materials contaminated with tapeworm eggs originating from human faeces. Pastures can be infested with eggs by tapeworm-carrying humans defecating on pastures, or from untreated sewage. The eggs hatch and develop into larvae which form tapeworm cysts (*Cysticercus bovis*) in the animal's muscle tissue. Cysticercus does not cause clinical signs in cattle even in heavy infections [33]. Under natural condition the presence of cysticerci in the muscle of cattle is not associated with clinical signs checked although experiments that calve given massive infection of *T. saginata* eggs developed with severe myocarditis and heart failure associated with developing cysticerci in the heart and cause of death between 14 to 16 days [4].

Diagnosis in Human: Since there is no clinical picture of *T. saginata* infection, the diagnosis in man is based on laboratory findings. Due to its asymptomatic nature, the disease is rarely diagnosed by clinically. The condition is suspected when the patient visits a physician with a complaint of crawling sensation in the perianal area [36]. Finding the eggs, the is best method of determining whether a person has a taeniid infection or not. But identification of species cannot be made from the eggs, because they are so similar. The exact species identification of *T. saginata* is made by examination of the scolex or proglottids that show typical species characteristics. Examination of the feces will help to find out presence of adult proglottids [1, 26]. Modified floatation methods have been attempted in diagnosing *taeniasis*, but the high specific gravity of *Taenia* eggs and confounding debris in the assayed matrix decreases the sensitivity of detection. Molecular techniques for detecting *Taenia* eggs are still low in numbers [1, 26]. In general, we should focus on the following morphological features in *T. saginata* diagnosis: Proglottids: species identification is done by observing gravid proglottids. Gravid segments of *T. saginata* show more than 13 uterine branches upon microscopic examination [36]. Scolex: *T. saginata* scolex lacks hooks [36].

Diagnosis in Cattle

Meat Inspection: Inner and outer masseter muscles, the tongue and the heart are incised and examined [33]. During inspection, each predilection sites were inspected according to the guide line by MoA [37] as follows; for Masseter muscle the deep linear incisions were made parallel to the mandible; the tongue was examined from base to top, the hearts were incised from base to apex to open the pericardium and incision was also made into cardiac muscle for detail examination. Deep, adjacent and parallel incisions were made above the point of elbow in the shoulder muscles. Examination of kidney and liver was also conducted accordingly. If a carcass is considered to be heavily infected then the carcass, meat, offal and blood all are 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 [38]. Immunological diagnosis: detection of serum level of specific antibodies (IgG, IgM) by ELISA [36].

Zoonotic Importance: *Taenia saginata* is a very long (3-15 meters in length) tapeworm parasite, whose adult form is found attached to the small intestinal tracts of human beings. In man, it has been known to live for 20 years within a single individual. It is an intestinal parasite of cattle and humans, causing *taeniasis* in humans. It is found globally and most prevalent where cattle are raised and beef is consumed. It is relatively common in Africa, some parts of Eastern Europe, Southeast Asia and Latin America. Humans are generally infected as a result of poor hygiene [6]. The effect on human health is generally slight and symptoms may vague or absent. *Taeniasis* has debilitating effect on people who already have live of protein deficiency diets suffer from iron deficiency and infested by hook worm [10]. *T. saginata* in small intestine of humans absorbs digested food and its proglottids migrate to different organs causing different signs [2]. *T. saginata* infection is usually asymptomatic. However, heavy infection often results in weight loss, dizziness, abdominal pain, diarrhea, headaches, nausea, constipation or chronic indigestion and loss of appetite. There can be intestinal obstruction in humans and this can be alleviated by surgery. The tapeworm can also expel antigens that can cause an allergic reaction in the individual. It is also rare cause of pancreatitis, cholecystitis and cholangitis

WHO. [39] states that the disease can also cause obstruction of the bowel, stomach-ache and migrating proglottids cause inflammation of the appendix, inflammation of the bile duct, unpleasant surprise when seen in the feces; whereas Teka G. [34] stated that *taeniasis* in humans causes anal pruritis due to emerging tapeworm segments but with severe infection humans may experience increased appetite or loss of appetite, abdominal discomfort and digestive upset.

Generally, according to WHO.[39] 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).
- Malnutrition - very large numbers of adult *Taenia* tapeworms present in the intestinal tracts of man can result in the malabsorption 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.
- 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.
- Poor hair quality - severe malnutrition and malabsorption of vitamins, minerals and proteins can result in reduced quality of the hair.
- Body weakness, headaches, dizziness, irritability and delirium.
- 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.

Economic Importance: While ill-health caused by the adult worms in humans gives rise to high medical costs [40], the economic losses due to bovine cysticercosis are mainly due to condemnation, refrigeration 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 [41]. Attempts to reduce the prevalence of *T. saginata* in humans and their *cysticerci* in cattle may have a considerable impact on the economics of meat production industries. *Cysticercosis* in cattle is a significant food safety problem and causes economic loss in food production. This will be particularly important where export industries are involved, since most importing countries have stringent regulations designed to prevent the importation of infected meat [27]. The cost implication can be broken down into those involved in treating human *taeniasis* and cattle carcasses (cost of freezing, boiling) or condemned, as well as the cost

involved in the inspection procedures. The average annual loss due to taenicidal drugs for treatment in Ethiopia was estimated to be 4, 937, 583 Ethiopian birr [11, 42, 43]. This mainly arose from the loss of value in abattoirs resulting from boiling the meat to kill the cyst, as the presence of cysticerci in the meat would be a serious obstacle to meet the import regulations of the recipient countries [44].

Treatment: There are a number of taenicidal drugs available in the market for treating *taeniasis* in human. The most widely used systemic drugs for the treatment of *T. saginata* is niclosamide and praziquantel [1, 42]. Niclosamide is effective at dose rate of 2000 mg and it damages the worm to such an extent that a purge following therapy often produces the scolex. Praziquantel at a dose rate of 5-10 mg per kg also has been reported highly effective but the scolex is partially digested and often not recovered [1]. Other drug used in treatment of *T. saginata* is mebendazole followed by purgatives like magnesium sulphate to expel the dead worms [15]. Treatment also consists of refrigeration (carcass moved to a freezer at ≤15°F and kept there for a minimum of ten days) or heating (carcass is heated throughout to a minimum internal temperature of 140°F).

In cattle treatment with compounds such as albendazole (50 mg per kg), praziquantel (50 mg per kg), mebendazole (50 mg per kg) can be given but they are not fully effective [33].

Control and Prevention: Control of cysticercosis aimed at breaking the epidemiological cycle of *T. saginata* infection. This involves cattle and humans, the intermediate host and final host respectively [26].

In cattle: Sanitary measures are important to ensure:

- Improvement of livestock farming techniques, for example, the establishment of cattle farms with controlled hygienic conditions in which the animals do not have access to pasture contaminated by human feces [45].
- Reinforcement of veterinary inspections during slaughter in abattoirs and more meat inspection both in municipal slaughter houses and slaughter establishments at markets [18].
- Vaccination of cattle would the most cost-effective control strategy. It has been shown that the *T. saginata* oncosphere extracts and oncosphere secretions produce a high level of protective immunity to challenge infections with *T. saginata* eggs [45]. More recently, an *18kDa T. saginata* oncosphere secreted and surface expressed adhesion molecule *HP6* was used to successfully vaccinate calves against oral challenge with *T. saginata* eggs. However, no vaccine is currently marketed [18].

Generally, cattle exposure to raw sewage and effluent is a known risk for producing cysticercosis. Cattle producers can reduce the risk of beef measles by providing adequate numbers of toilets and handwashing facilities and insisting that all employees and visitors use them to prevent the contamination of feed bunks, feed storage areas, ditches or other areas with human waste. Portable toilets must be correctly cleaned to prevent human waste from contaminating lagoon water that is used to flush cattle holding areas.

In human: As stated by Blancou *et al.* [18] control of infection in human is based on the following:

- Diagnosis of carriers and treatment with a taenicides (e.g. Niclosamide or praziquantel) to eliminate the parasite that is the source of contamination for the environment and cattle.
- Improvement of personal hygiene and installation of good sanitary accommodation for family use.
- Enhance environmental hygiene and suitable drainage of waste water.
- Continuous public health education of the population, stressing the danger of consumption of uncooked or partially cooked beef.
- Mass education to use latrines and avoid eating of raw meat.
- Avoid eating of raw meat (Kurt, Lablab and kitffo) that is not inspected by well experienced meat inspector.
- Infected meat and meat products must be undergoing the processes of freezing and boiling.
- There should be strong and close collaboration between medical and veterinary professionals to reduce impact of the disease both in humans and animals.
- Strict routine meat inspection of slaughtered animals should be carried out.

REFERENCES

1. Smyth, S.D., 1994. Introduction to Animal Parasitology. 3rd ed. London, Hodder and Stoughton, pp: 250-263.

2. Urquhart, G.M., J Armour, J.L. Duncan, A.M. Dunn and F.W. Jennings, 1996. Veterinary Parasitology. 2nd ed. London, Blackwell Science, pp: 121-124.
3. Cabaret, J., S. Geerts, M. Madeline, C. Ballandonne and D Barbier, 2002. The urban sewage sludge on pastures: the cysticercosis threat. Veterinary Research, 33: 575-597.
4. Utulas M., Esatgil and Tuzer, 2007. Prevalence of hydatidosis in slaughtered animals in Thrace, Turkey Parasitology Dergisit, 31(1): 41-45.
5. WHO., 1996. Investigating in health research and development. Report of the committee on health research relating to future intervention options. Geneva, Switzerland: WHO, pp: 270-275.
6. Minozzo, J.C., R.L.F. Gusso, E.A. De Castro, O. Lago and V.T. Soccoi, 2002. Experimental Bovine Infection with Taenia saginata Eggs: Recovery Rates and Cysticerci Location. Braz. Arch. Biol. Technol., 45: 4.
7. Gyles, C.L., J.F. Prescott, J.G. Songer and C.O. Thoen, 2004. Pathogenesis of bacterial infection in animal and its product hygiene. 3rd ed. USA: Blckwell Science, pp: 122-119.
8. Neva, F.A. and W.H. Brown, 1994. Basic Clinical Parasitology. 6th Edn., Appleton and Lange, Norwalk, Conn., ISBN: 9780838506240, pp: 356.
9. Carpio, A., 2002. Neurocysticercosis: An update. Lancet Infect Dis., 2: 751-762. DOI: 10.1016/S1473-3099(02)00454-1.
10. FAO., 2004. Veterinary Public Health Disease Fact Sheet: Cysticercosis.
11. Fufa, A., 2006. Study on the prevalence of Bovine Cysticercosis at Awassa town and its surroundings, southern Ethiopia. Addis Ababa University, Faculty of Veterinary Medicine, Debrezeit, Ethiopia.
12. FAO., 1991. Report of the FAO expert consultation on helminthic infections of livestock in developing countries (AGA, 815), FAO, Rome, pp: 16-17.
13. McFadden, A.M.J., D.D. Heath, D.D. Morley and P. Dorny, 2011. Investigation of an outbreak of *Taenia saginata* cysts (Cysticercusbovis) in dairy cattle from two farms. Veterinary parasitology, 176: 177-184
14. Oladele, D., M. Gracey, S. Brad, G. Stany and B. Jef, 2004. Bovine Cysticercosis: Preliminary Observations on the Immuno-Histochemical Detection of *Taenia saginata* Antigens in Lymph nodes of an Experimentally Infected Calf. Canadian Veterinary Journal, 45: 852-855.
15. Soulsby, E.J.W., 1982. Helminths, Arthropods and Protozoa of Domestic Animals. 7th ed. London, Balliere Tindal.
16. Andrews, A.H., R.W. Blowey, H. Boyd and R.G. Eddy, 2003. Bovine Medicine: Disease and Husbandry of cattle. 2nd ed. Singapore, Blackwell Science, pp: 360-363.
17. Gracey, J.L., 1981. Thornton's Meat Hygiene. 9th ed. London, Ballier Tindal. 24-28 Oval Road, London NW17DX.
18. Blancou J., G. Uilenberg, P-C. Lefevre and R. Charmette, 2010. Infectious and Parasitic Diseases of Livestock. Lavoisier, 2: 1646.
19. Mohammed, A.A. and C. Waqtola, 2006. Medical Parasitology for medical laboratory technology students. Jimma University, Faculty of Veterinary Medicine. Jimma, Ethiopia, pp: 332-370.
20. Kebede, N., G. Tilahun and A. Hailu, 2009. Current Status of Bovine Cysticercosis of Slaughtered Cattle in Addis Ababa Abattoir, Ethiopia. Tropical Animal Health and Production, 41: 294-291.
21. Eom, K.S., H.K. Jeon and H.J. Rim, 2009. Geographical distribution of Taenia asiatica and related species. The Korean Journal of Parasitology, 47 Suppl, S115-24. doi:10.3347/kjp.2009.47. S. S115.
22. Kebede, N., 2008. Cysticercosis of slaughtered cattle in northwestern Ethiopia. Research in Veterinary Science, 85(3), 522-526. doi: DOI: 10.1016/j.rvsc.2008.01.009.
23. Carabin, H., D. Perez, J.L.J. Gilpen and R.A. Greenfield, 2005. Animal Diseases as a Possible Consequence of Biological Attack. In M. S. Bronze, & R. A. Greenfield (Eds.), Biodefense: Principles and Pathogens (pp: 737). Norfolk, England: Horizon Bioscience.
24. Cestodes, 2007. In L.S. Garcia, J.A. Jimenez and H. Escalante (Eds.), Manual of Clinical Microbiology (9th ed., pp: 2166). Washington, D.C.: ASM Press.
25. Gajadhar, A.A., W.B. Scandrett and L.B. Forbes, 2006. Overview of food- and water-borne zoonotic parasites at the farm level. Revue ScientifiqueEt Technique (International Office of Epizootics), 25(2): 595-606.
26. Lefevre, P.C., J. Blancou, R. Chermette and G. Uilenberg, 2010. Infectious and parasitic or helminthes zoonotic diseases, Bacterial diseases, fungal diseases and parasitic diseases, Volume 2, Lavoiser, pp: 1219-1217.
27. Harrison, L.J.S. and M.M.H. Sewell, 1991. The Zoonotic Taeniae of Africa. In: Parasitic Helminthes and Zoonoses in Africa. London. Unwin Hyman, pp: 54-56.

28. Hailu D., 2005. Prevalence and risk factors for *T. saginata* Cysticercosis in three selected areas of eastern Shoa. MSc Thesis. Addis Ababa University, Faculty of Veterinary Medicine, Debrezeit, Ethiopia.
29. Megersa, B., E. Tesfaye, A. Regassa, R. Abebe and F. Abunna, 2009.Bovine Cysticercosis in cattle slaughtered at Jimma Municipal Abattoir, Southern Ethiopia.
30. Abunna, F., G. Tilahun, B. Megersa, A. Regassa and B. Kumsa, 2008.Bovine Cysticercosis in Cattle Slaughtered at Hawassa Municipal Abattoir, Ethiopia: Prevalence, Cyst Viability, Distribution and Its Public Health Implication. Zoonosis and Public Health, 55(2): 82-88.
31. Tembo, A., 2001. Epidemiology of Taenia saginata, Taeniasis/Cysticercosis in three selected agro climatic zones. MSc Thesis. Addis Ababa University, Faculty of Veterinary Medicine, Debrezeit, Ethiopia, pp: 28.
32. Mulugeta, A., 1997. Bovine Cysticercosis: prevalence, economic and public health importance, DVM Thesis. Addis Ababa University, Faculty of Veterinary Medicine, Debrezeit, Ethiopia.
33. Kassai, T., 1999. Veterinary Helminthology. 1st ed. New Delhi, Butter Worth. Heinemann, pp: 37-42.
34. Teka G., 1997. Food Hygiene Principles and Food Born Disease Control with special Reference to Ethiopia. Addis Ababa University, Faculty of Medicine, Department of Community Health, Addis Ababa, Ethiopia.
35. Mandal, S.C., 2012. Veterinary Parasitology at a Glance. 2nd ed. New Delhi, Ibdc, India, pp: 194-203.
36. Parija, J., 2004. Text book of Medical Parasitology. 2nd ed. New Delhi, All Indian Publishers, pp: 207-212.
37. Ministry of Agriculture. Meat Inspection Regulations, 1972. Legal notice no. 428 Negarit Gazeta. Addis Ababa, Ethiopia.
38. OIE., 2008. Terrestrial Manual. Cysticercosis, Chapter 2.9.5.
39. WHO, 2013. Taeniasis/cysticercosis. WHO Fact Sheet N°376.
40. Fan, P.C., 1997. Annual economic loss caused by *T. saginata* Taeniasis in East Asia. Parasitol. Today, 13: 194-235.
41. Grindle, R.J., 1978. Economic losses resulting from bovine cysticercosis with special reference to Botswana and Kenya. Trop. Anim. Hlth. Prod., 10: 127-140.
42. Ahmed, I., 1990. Bovine Cysticercosis in animals slaughtered at Nekemte abattoir. DVM Thesis. Addis Ababa University, Faculty of Veterinary Medicine, DebreZeit, Ethiopia.
43. Dawit, S., 2004. Epidemiology of *Taenia saginata* taeniasis and cysticercoids in north Gondar zone, north western Ethiopia. DVM Thesis. Faculty of Veterinary Medicine, Addis Ababa University, Debrezeit, Ethiopia.
44. Gracey, J.L., 1994. Thornton's Meat Hygiene. Economic losses resulting from bovine cysticercosis with reference to Botswana and Kenya. Tropical Animal Health Production, 10: 127-140.
45. Lightowlers, M.W., R. Rolfe and C.G. Gauci, 1996. *Taenia saginata*: Vaccination against Cysticercosis in cattle with recombinant oncosphere antigens. Experim.parasitol., 84: 330-338.