

Review Article

Public Health Impact of Bovine Cysticercosis in Ethiopia: A review

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Abstract

Zoonotic effects of Bovine cysticercosis and its causative agents are metacestode at the stage of cestode and *Taenia (T) saginata* for humans. The reviewed result stated that the cosmopolitan and its distribution of Bovine cysticercosis are common in the world. Distribution is associated with economic conditions, religious and close proximity of humans to cattle. Its life cycle is indirect and entirely dependent on the link between man and cattle. So, this review was indicated that any break between human and cattle results in the total elimination of the parasites. Cysts of *Cysticercus (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. In Ethiopia except the heart other organs are consumed at raw meat or under cooked. Most research result showed that man consumes these muscles containing viable *Cysticercus* and a tapeworm develop and poses a potential public health hazards than *Taeniasis*. The custom of eating raw or undercooked beef dishes and the habit of defecating in open fields and allowing cattle to graze in such fields made *Taeniasis* of human and cysticercosis of cattle in Ethiopia. The prevalence of the disease both in human and animals is high. *T.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. In Ethiopia most Slaughtering practices are often carried out in the field in the absence of abattoirs. This allows the parasite to continue its life cycle in the coming future. Therefore avoiding the consumption of raw meat, slaughtering animals on the field and stop free grazing is the prevention measure of cysticercosis.

Keywords: Bovine; Cysticercosis; Public Health; Zoonotic; Ethiopia

Introduction

Tapeworm infection has been recorded in 1500 years ago and it is the earliest human parasite. *Tania saginata* is characterized in worldwide zoonotic cestode whose epidemiology is ethnically and culturally determined with estimation of 50-77 million annually. Both adult and larval forms of *T. saginata* are hazardously affected health of their respective hosts, either directly or indirectly with several secondary infections, particularly in human. The occurrence of metacestode larval stage of *C. bovis* in cattle musculature is causing *b. cysticercosis* while the adult stage of worm in human small intestine is characterized by *Taeniasis* [1,2]. 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 haz-

ardous except heart of animals' [3]. Poor hygiene, primitive livestock husbandry practice and inadequate meat inspection management and control policy are the transmission agent of the parasite [4]. Bovine cysticercosis and *Taeniasis* are the two commonly known parasitic diseases which are facilitated by poor hygienic and insufficiently cooked or sun-cured raw meat conditions [2]. The parasite is very common in Africa and endemic in central and East African countries like Ethiopia, Kenya and Zaire [5]. The custom of eating raw or undercooked beef dishes such as *kourt*, *lebleb*, *kiteffo* and the habit of defecating in open fields coupled with cattle to graze in such fields which are cause of *Taeniasis* for human and cysticercosis for cattle [6]. A high prevalence of human infection in different agro-climatic zones of the country has been reported [7]. Estimates made by different investigators on prevalence of *Taeniasis* in Ethiopia is vary widely from 2% - 16% to over 70% [8]. Among the prevalent livestock

diseases, zoonotic once are the major constraint to the development of livestock productivity in Ethiopia. Of zoonotic diseases, bovine cysticercosis is the disease that remains a major public health problem in lower income and some industrialized countries [9]. *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 [10]. FAO [11] stated that the disease causes the obstruction of the bowel, stomach-ache and migrating proglottids, inflammation of the appendix and the bile duct, unpleasant surprise when seen in the feces. Whereas Teka [6] stated that Taeniasis causes anal purities due to emerging tapeworm segments and, abdominal discomfort and digestive upset.

Cysticercosis affects both the health of the consumer and 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 [12]. Generally loss from cysticercosis is determined by disease prevalence, grade of animals affected, potential market policy of cattle and treatment cost for detained carcasses. The average annual loss due to taenidicidal drugs for treatment in Ethiopia was estimated to be 4,937,583 Ethiopian birr [12-14]. Inadequate health education and low availability of taenicides are the major obstacles for the control infections in Ethiopia [12,15]. In foreign trade, Ethiopia is placed to export live animals to the Middle East North and West Africa. This is a major public and animal health problems that transmitting *T. saginata*/Cysticercus [16]. Therefore the objective of this review is to highlight the status, control, prevention strategies, and public health and economic impacts of the disease of bovine cysticercosis in Ethiopia.

Bovine Cysticercosis

Etiology: Bovine cysticercosis is a disease that affects the musculature of cattle and is caused by the metacestode stage of human intestinal cestode and *T. saginata* [17]. Within the taxonomic classification *T. saginata* and its metacestode, *C. bovis* and the unarmed beef tapeworm is classified under the kingdom of Animalia, phylum of Platy helminthes, class of Cestode, order of Cyclops halide, family of Taenidae, genus of *Taenia* and species of *T. saginata* [18-20]. 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 [20,21]. Its body divided in to three distinct parts consisting of head (Scolex), neck and strobilla [3]. The head or scolex is bearing the attachment organs, a short unsegmented neck and chain of segments. The chain is known as strobilla and each segment as proglottids. Unlike other taenicides, 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 re-

productive organs [18].

Taenia eggs are passed in the stools or discharged from ruptured segments, spherical in shape, very resistant and remaining for 6 months in pasture and vegetables, 5 weeks in water, 10 weeks in stool or hay and 12 weeks in silage sludge. *Taenia* eggs measure about 30-45 µm in diameter; contain an oncosphere (Hexacanth embryo) bearing three pairs of hook which have a thick, brown, radically striated embryo with a shell composed of hooks and outer oval membranous coat of a true egg shell lost from the fecal eggs [19]. 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 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 [19].

Epidemiology

Host range: Cattle are intermediate and humans are the final hosts of *T. saginata*. In all age of cattle are susceptible for this parasite whereas young age groups are more susceptible than the others. Sometimes Parasitism is observed in other ruminants like sheep, goats, antelopes, gazelles and buffaloes, but the development of *Cysticercus* is unlikely to the others [15]. The geographic distribution status of Taeniasis is more serious and less recognized for public health problems in the developing countries [2]. Whereas, the distribution of Bovine cysticercosis is an international and it is very common in Africa. It is highly endemic in areas of Central and East African countries like Ethiopia, Kenya and Zaire [5]. In Ethiopia the custom of eating undercooked beef dishes such as kourt, lebleb and, kiteffo and the habit of defecating in open fields coupled with cattle for grazing are made Taeniasis of human and cysticercosis for cattle [6]. A high prevalence of human infection in different agro-climatic zones of the country has been reported [7]. Estimates made by different investigators on prevalence of Taeniasis in Ethiopia is vary widely from 2% - 16% to over 70% [8]. Low availability of taenicides is a constraint and the use of herbal drugs do not eliminate this parasite from human population and the proglottids fecal matter is resulting in cysticercosis in the cattle [6]. Bovine cysticercosis has been reported from different parts of the country (Table 1).

Place	Percent Prevalence	Reference
Addis Ababa	13.3%	[22]
Debre Zeit	13.85%	[21]
Mekelle	7.23%	[26]
Amhara National Regional State	18.49%	[22]
Bahir Dar	19.4%	[26]
Nekemta	21.7%	[13]
Gondar	4.9%	[14]

Table 1. Bovine cysticercosis in different parts of Ethiopia.

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. Most researchers underline that there is higher prevalence of Taeniasis in those who consumes raw meat than those having cooked meat dishes [7,22,28-26]. But no significant variations were observed between sex and religion. In contrast, Megersa et al. [25] 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. According to Abunna et al. [22] and Hailu [26] reported that Taeniasis is significantly association with sexes. Whereas the prevalence is higher in males than females that could be due to economic reasons and cultural practices of males are not prepared their dish at home rather consume at restaurants and butcheries [22]. Metacestode is distributed in different organs and found throughout the edible parts of the carcass like masseter muscles, cardiac muscles, triceps muscles, thigh muscles, shoulder muscles, diaphragm, intercostals muscles, liver, heart, tongue, lung and kidney [20,24,28,30]. The tongue, masseter muscles, heart muscles, triceps muscles and thigh muscles are the main predilection sites of the cysts [23]. Abunna et al. [22] reported that the cysts in heart (29.2%), shoulder muscle (25.3%), masseter muscle (26.7%), tongue (10.4%), diaphragm (5.4%), liver (1.4%), lung (0.9%) and kidney (0.5%) were reported. While unlikely Kebede [31] reported that the cysts from tongue (0.61%), masseter muscles (0.59%), shoulder muscles (0.26%), heart (0.26%) and liver (7.45%) was found.

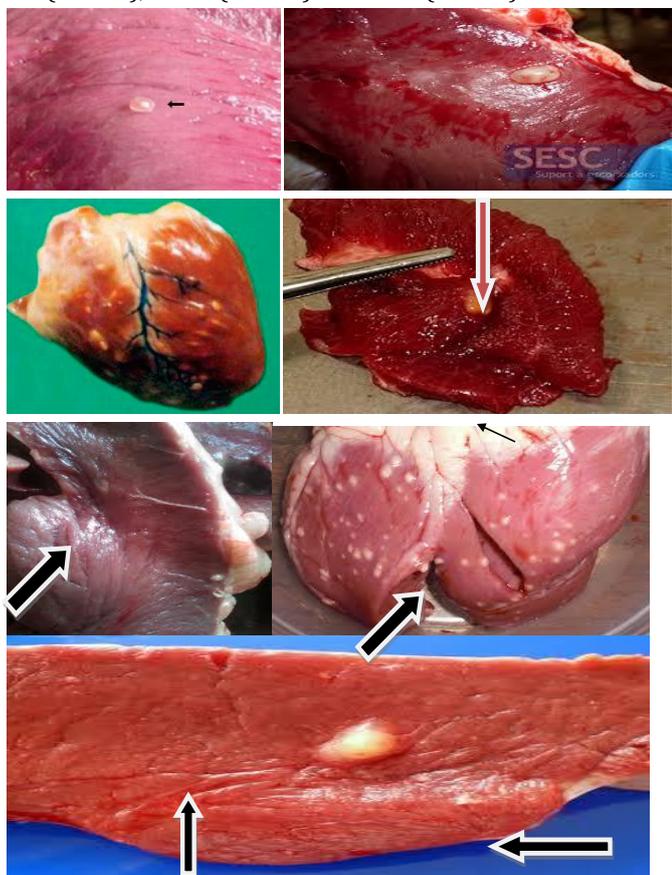


Figure 1. Cysticercus bovis cyst distribution in different organs.

The prevalence of bovine cysticercosis reported by various researchers which was underestimated due to the presence of many infections causes, undiagnosed report and exclusively routine based meat inspections. However, in Ethiopia the procedure described under meat inspection and regulation notice number without strict at abattoirs is developed as 1972,428.

Source of infection and mode of transmission: by itself human beings are the main source of parasites and human habits are causing for the spread of bovine cysticercosis. Both transhumance and nomadic systems ways of lives are mostly characterized by human have common habitat with animals which humans are exposed to infected feces. Infection of cattle is highly associated with non-hygienic disposal of stool from infected humans and indirectly from human sewage on pasture [27]. In Ethiopian customs and traditions are known by consuming raw, sun-cured and inadequately cooked beef dishes which are containing viable cysticerci perpetuate and causes of human infections [6]. Man cannot spread Taeniasis to his own species. Management of animals in their natural environment predisposes them to infection. Cattle grazing in a communal fallow land have a higher risk for T.saginata eggs and frequently 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 [15]. In developing countries like Ethiopia, cattle are reared on extensive scale and human sanitation is poorly developed which makes the incidence of T.saginata. Calves are infected usually in early life at the first few days after birth from infected stockmen whose hands are contaminated with Taenia eggs [6,28].

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 human host. It also produces proglottids segment containing a considerable number of shed on defecation eggs. Taenia eggs are containing an embryo (Oncosphere) which are spread into the environment through sewage and ingested by the intermediate hosts (Cattle). In cattle the embryo moves from the intestine to striated musculature. Here they develop into small vesicles called cysticerci containing one protoscolex, head of the future adult tapeworm [27]. The metacestode are found throughout the edible parts of the carcass which included masseter muscles, cardiac muscles, triceps muscles, thigh muscles, shoulder muscles, diaphragm, intercostals muscles, liver, heart, tongue, lung and kidney, [20,24,25]. The tongue, masseter muscles, heart muscles, triceps muscles and thigh muscles are the main predilection sites of the cysts [24]. Prevention of human Taeniasis and bovine cysticercosis is achieved by interrupting the life cycle of the parasite [6].

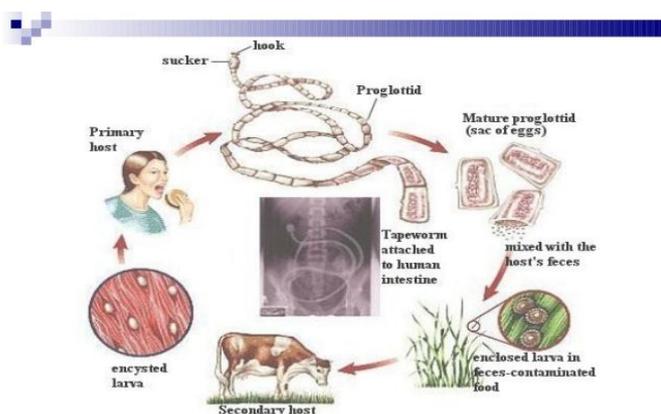


Figure 2. Life cycle of *T. saginata* (Source: slide share).

Pathogenesis and clinical manifestation

Disease in human: Human Taeniasis is manifested as mild non-specific gastrointestinal illness including symptoms of abdominal pain, digestive disturbance, nausea, diarrhea and anorexia [9]. The tapeworm utilizes nutrition of man thus causing great loss of nutrient in the hosts. Presence of large number of *T. saginata* causes enteritis [31].

Disease in cattle: *Cysticercus* does not cause clinical signs in cattle even in heavy infections [27]. Under natural condition the presence of cysticerci in the muscle of cattle is not associated with clinical signs checked although experiments that calves 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 [9]. Heavy infection in cattle may result in fever, gastroenteritis, muscle stiffness and weight loss particularly in young animals [11].

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 [31]. Signs and symptoms of Taeniasis are determining the finding eggs whether a person has a *Taenia* infection. 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 [19,15]. Modified floatation methods have been attempted in diagnosing of Taeniasis, but the high specific gravity of *Taenia* eggs and confounding debris in the assayed matrix is decreasing in the sensitivity of detection. Molecular techniques for detecting *Taenia* eggs are still low in numbers [19,15]. In general we should focus on the following morphological features in *T. saginata* diagnosis. Whereas, proglottids species are observed by the identification of gravid proglottids. Gravid

segments of *T. saginata* show more than 13 uterine branches upon microscopic examination and lacks of hooks [31].

Diagnosis in cattle: Meat is inspected, incised and examined with the inner and outer masseter muscles; the tongue and the heart [31]. During inspection, each predilection sites were inspected according to the guide line of the Ministry of Agriculture [31] as deep linear incisions parallel to the mandible for Masseter muscle, examined from base to top for the tongue, incised from base to apex to open the pericardium for the hearts and incision was also made for cardiac muscle and its detail examination. Examination of kidneys' liver and immunological diagnosis was conducted in detection of serum level of specific antibodies (IgG, IgM) [30].

Differential diagnosis: According to Tembo [7], metacestode in cattle should be differentiated from *Sarcocyst* species which form white, soft nodules with 6-4 mm in diameter located mainly in the esophagus, in the heart and other muscles. Whereas the length of *Onchocerca dukei* is 6-3 mm in diameter which form intramuscular and subcutaneous nodules that are firm to touch and reveal worms when sectioned. *Cysticercus dromedaries* (*C. cameli*) is the metacestode of *T. hyenae* which is twice as large as *C. bovis* measuring 18-12 mm in diameter, pearly white in color and possesses a double row of hooks on the lateral part of invagilated scolex.

Treatment: There are a number of taenicial drugs available in the market for treating Taeniasis in human. The most widely used systemic drugs for the treatment of *T. saginata* in Ethiopia is niclosamide and prasiquantel [13,19]. Niclosamide is effective at dose rate of 2000mg and damages the worm at purge followed by therapy and often produces the scolex. Prasiquantel at a dose rate of 10-5mg per kg also has been reported at highly effective but the scolex is partially digested and often not recovered [19]. Other drug used in treatment of *Taenia saginata* is mebendazole followed by purgatives like $MgSO_4$ to expel the dead worms [18].

Traditional knowledge of Taeniasis treatment:

Ahmed [13] reported that most people, especially rural inhabitants use different types of traditional herbal drugs to routine self-de worming practices. In cattle, not fully effective compound treatments like Alebendazole (50mg per kg), Praziquantel (50mg / kg) and Mebendazole (50mg/ kg) are considered [31]. Some of the traditional drugs (table 2).

No	Local name	Scientific name	Parts of plants used
1	Bizana	<i>Croton macrustachys</i>	Bark (hard outer cover)
2	Duba ferie	<i>Cucurbita pepo: the pump kin</i>	Seed
3	Enkoko	<i>Embelia skimpier</i>	Fruit
4	Kosso	<i>Hygeia Abyssinica</i>	Flower
5	Metre	<i>Gilvus Lotooides</i>	Seed
6	Wogert	<i>Silen Macrosclen</i>	Root

Table 2. Traditional anticestodal drugs.

Importance Disease

Public health 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. Therefore, 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, Eastern Europe, Southeast Asia and Latin America. Humans are infected by as a result of poor hygiene [1]. Taeniasis has debilitating effect on people who already have live of protein deficiency diets suffer from iron deficiency and infested by hook worm [11]. *T. saginata* is found in small intestine of humans which computed through the absorption of the digested food and its proglottids migrate to different organs causing different signs [20]. *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 [10] and FAO [11] stated 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 from the feces; whereas Teka [6] stated that Taeniasis in humans causes anal purities due to emerging tapeworm segments but with severe infection humans may experience increased appetite or loss of appetite, abdominal discomfort and digestive upset. Generally, WHO [10], stated that adult *Taenia* parasites are located in the intestinal tracts of humans with the 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 in the intestinal tracts of man resulted 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.
- Poor hair quality - severe malnutrition and

malabsorption 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.

Economic Importance

Economic loss from cysticercosis is determined by disease prevalence, grade of animals affected, potential market policy of cattle and treatment cost for detained carcasses. 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 [5]. 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 [14-13].

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 [15].

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 [29].

© Reinforcement of veterinary inspections during slaughter in abattoirs and more meat inspection both in municipal slaughter houses and slaughter establishments at markets.

© Vaccination of cattle would be 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 [29]. 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.

In human: control of infection in human is based on

Diagnosis of carriers and treatment with a taeniides (e.g. Niclosamide or praziquantel) to eliminate the parasite that is the source of contamination for the environment and cattle.

- Consider 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.

Conclusion

Cysticercosis is an important zoonotic disease that affects both human and animals in Ethiopia. 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 favor for continual existence of the parasite within the human and animal population.

Recommendations

- There should be public awareness about the health and economic importance of the disease through social and public media.

- 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.
- The community should use latrines to improve personal as well as environmental hygiene.
- Untreated human feces should not be used as fertilizers.
- Strict routine meat inspection of slaughtered animals should be carried out.
- Further researches should be conducted on the epidemiology and control strategies of cestode in Ethiopia.

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