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Review on Prevalence and Public Health Importance of Bovine Cysticercosis in Ethiopia

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Abstract

One of the most common parasite infections in sub-Saharan Africa is bovine cysticercosis, or *Taenia saginata*. *T. saginata* is more common in underdeveloped nations, particularly Ethiopia, where people customarily eat raw, inadequately cooked, or sun-cured meat and sanitary conditions are poor. Raw meat consumption, outside defecation, inadequate waste management, a lack of public knowledge, and backyard abattoir practices were the variables linked to the illness. In addition to its zoonotic significance, taeniosis/cysticercosis results in economic losses due to the rejection of whole carcasses and edible offal and the expense of treating infected humans. Thus, regular meat inspections and raising public knowledge of the risks associated with eating raw meat must be prioritized.

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Introduction

Ethiopia has an extremely diverse topography, a wide range of climatic features and a multitude of agro-ecological zones that are suitable to host a very huge animal population. Ethiopia is believed to have the largest livestock population in Africa (Mekonnen, 2019).

In Ethiopia, livestock are the backbone of the economy and are essential to farming families' livelihoods since they produce direct cash income, foreign exchange, milk, meat, skin, power, organic fertiliser, manure, and traction (Hailesilassie, 2016).

However, because of management limitations, widespread disease, and malnutrition, its productivity is still just limited. One significant obstacle to the sub-sector's growth is parasitism. However, there is lack of information on the relative hierarchy, economic damage, and epidemiology of certain parasite diseases. Determining the kind and extent of control intervention that should be considered is crucial for comprehending these situations (Jobire *et al.,* 1996; Gunn and Pitt, 2022).

Meat-borne diseases are prevalent in developing nations such as Ethiopia, due to several factors, including inadequate food safety regulations, inadequate sanitation and food handling procedures, a lack of funding for safer equipment, and a lack of food handler education (WHO, 2004). National Hygiene and Sanitation Strategy Program (WHO/FAO, 2005) reported that about 60% of the disease burden was related to poor hygiene and sanitation in Ethiopia. In realizing the severity of food safety problems and control of parasitic meat-borne zonoosis in Africa, the Food and Agricultural Organization (FAO) and the World Health Organizations (WHO) of the United Nations (UN), passed a resolutions to improve the food safety situation in Africa (FAO/WHO, 2005).

Bovine cysticercosis is one of the parasites that affects cattle's muscles. Its entire life cycle depends on the relationship between cattle and humans. Therefore, any disruption in these connections may lead to the parasite's complete eradication (Urquhart *et al.,* 1996; Kumar and Kumar, 2024). The adult tapeworm, *T. saginata* occurs in the small intestine of the definitive host, man and the metacestode (*Cysticercus bovis*) is found in cattle that serves as main intermediate host (Soulsby, 1982). Bovine cysticercosis is also known as beef measles. It is prevalent in most countries of the world (Smyth; 1994; Urquhart *et al.,* 1996; Semie *et al.,* 2015). Financial losses can be considerable when large numbers of animals are affected, such as in feedlot. Most incidents arise as a result of direct exposure to proglottids shed from farm workers. There are also some reports of large scale outbreaks resulting from sewage contaminated feed or forage (Wayne, 2002). Parasitic diseases are highly prevalent in Sub-Saharan Africa and incur severe economic losses by reducing productivity. *T. saginata* taeniasis/bovine cysticercosis is one of the major parasitic diseases, which does not only lead to economic loses, but also adversely affect public health. The distribution of *T. saginata* is wider in developing countries, where hygienic conditions is poor and where the inhabitants traditionally consume raw or insufficiently cooked or sun cured meat (Kumar and Kumar, 2024).

Hence, cysticercosis is an important public health and economic problem because of its consequences on human nutrition and economy of some countries (Wanzala *et al.,* 2003). Bovine cysticercosis is one of the parasites that affects cattle's muscles. Its entire life cycle depends on the relationship between cattle and humans. Therefore, any disruption in these connections may lead to the parasite's complete eradication (Lightowlers, 2003), since it is shown that the eggs can survive in sewage (Arundel and Adolph, 1980). The larvae of *T. saginata* still cause significant problems in many parts of the world. In Ethiopia, the adult parasite in human and the cyst in cattle population is widespread nationwide but differ from region to region. Despite all these facts precise and up-to-date comprehensive information on distribution and control of bovine *taeniosis* affecting animals and humans from Ethiopia is not available. Therefore, the major objective of the present review paper is to compile recent information on prevalence, distribution and control intervention of bovine cysticercosis in Ethiopia.

Taxonomy

Taenia saginata and its metacestode *Cysticercus bovis*, the unarmed beef tapeworm, belong to the class Cestoda order Cyclophyllidea Family Taeniidae and Genus Taenia (Soulsby, 1982; Symth, 1994; Urquhart *et al.,* 1996; Madrigal, 2020).

Morphology

Adult worm

Taenia saginata, the beef tapeworm, is a large worm measuring 3-10 meters in length rarely the adult measures up to 15m (Soulsby, 1982; Urquhart *et al.,* 1996). It resides in the small intestine of humans where it attaches using its scolex and can survive for many years. The adult is ribbon-shaped, multi-segmented and hermaphroditic flatworm its body divided into three distinct parts consisting of scolex (head), neck and strobila (Soulsby, 1982). The scolex, measuring 1mm to 2mm in diameter, has four strong hemispherical suckers. There is no rostellum and hooks and the predilection site in the intestinal mucosa is in the proximal part of the jejunum (WHO/FAO/OIE, 2005; OIE, 2012). Proglottids are continuously produced by the short, unsegmented neck, which has a germinal structure directly behind the scolex (Urquhart *et al.,* 1996; Jeon and Ecom, 2024).

T. saginata is ribbon-shaped flattened, multi-segmented and hermaphrodite. The body is divided into three distinct parts of scolex (head), neck and strobila. *T. saginata* measures 4 -8 meters in length and rarely measured up to 15m (Urqguhart *et al.,* 1996). The gravid segments are 10-20 mm long and are usually shaded singly and leave the host spontaneously or crawling about the body, clothes and beds of human beings self and cross- fertilization between proglottids is possible. The gravid proglottids are 15 to 35mm long and 5 to 7mm wide filled with eggs, which detach from the strobila singly and leave the host via anus. This implies that coprological examination has a limited value in the diagnosis of *T. saginata* infection (Gebre Emanuel, 1997; Lateef *et al.,* 2020). Taenid egg passed in the faeces or discharged from ruptured gravid segment are sub-spherical to spherical in shape. The egg consists of hexacanth (six looked) embryo (oncosphere), thick, dark brown to yellow in color. There is an outer oval membranous coat, the true egg shell, which is voided in the faeces. Inside the inner envelope, develops into the embryosphere, which is made of "keratin" blocks and

gives the egg its characteristic radiated appearance (WHO, 1983; Lateef *et al.,* 2020).

Larvae

The round or oval cyst, when completely grown, has a scolex that invaginates into a fluid-filled vesicle (tail bladder) encased in a connective tissue capsule created by the host's tissue reacting (Gracey and Collins, 1992; Prykhodko *et al.,* 2015). The cyst is seen as small whitish vesicle and is found between muscle fibers (Fig 6). It is transparent and contains translucent fluid. The invaginated scolex is visible in the form of whitish spot at one end of the pole of the cyst (Troncy, 1989). As in the adult tapeworm, it has neither rostellum nor hooks (Soulsby, 1982; Urquhart *et al.,* 1996). Over a period of 3-4 months, the cysticercoids are formed after the egg is ingested and may remain viable in the intermediate host for up to 9 months or even up to the entire life of the host (WHO, 1983). The larval stages or metacestods are found in striated mussels of the intermediate host (Dunn, 1978). *C. bovis* is small (pea sized) oval in shape (OIE, 2001). *C. bovis* is grayish white, about 1cm in diameter and filled with fluid in which the scolex is often clearly visible (Smyth, 1994; Urquhart *et al.,* 1996; Hesham *et al.,* 2025).

Life Cycle T. saginata

The life cycle of *T. saginata* is indirect whereas they are relatively host specific for both larval and adult stages. The adult tapeworm's sole natural definitive host are humans.

Depending on the species, the adult tapeworm can reach complete development and reproductive maturity as soon as 10-12 weeks following host infection (Urquhart *et al.,* 1996; Jeon and Ecom, 2024). Human is infected by the ingestion of raw or under cooked parasitized meat (Biru, 1984 and WHO, 1983).

An infected person can shed as many as 1million eggs each day. Ingesting contaminated pasture infects bovine. The tape worm thrives in the small intestine of humans. As it matures, it produces segments with roughly 100,000 eggs apiece. In the faces or by migrating through the anus, the segments split off and go outside (Figure 1). In cattle, cysticerci are found predominantly in cardiac and skeletal musculature, and occasionally in other sites including liver, lung, kidneys and lymph nodes (Achollah, 2019).

Epidemiological Distribution of the Adult and Cyst Parasite

T. saginata is distributed globally but the infection is particularly important in Africa, Latin America, and Asia as well as in some Mediterranean countries. The prevalence of *T. saginata* in humans can be roughly classified into three groups: highly endemic regions with prevalence that exceed 10%; those with moderate prevalence; and those with prevalence below 0.1% or free from *T. saginata* taeniosis (Minozzo *et al.,* 2002). *T. saginata* infections also occur in developed countries, where standards of sanitation are high and meat is carefully inspected and generally thoroughly cooked. Taeniasis/cysticercosis spreads in developed areas of the world through tourists enjoying the consumption of lightly grilled meat, mass migration of labor and the export of meat unreliably passed by ''eye or knife'' inspection or from live animals imported from endemic areas (Jeon and Eom, 2006). Cattle are primarily raised by rural communities in Ethiopia using intensive husbandry techniques. In rural locations, factors including high population density, consumption of raw meat, lack of information, inadequate hygiene, and unsanitary infrastructure may make it easier for diseases to spread from animals to people (Fikire and Adugna, 2012). The prevalence of *C. bovis* in cattle population of Africa was 2.56% in Kenya (Kimari, 2017), 22.3% in Zaire and 6.67% in Chad (Gracey and Collins, 1992), 3.3% in Nigeria (Sabuwa *et al.,* 2020), 10% in Sudan (Aboelbashar, 2014), 3% in Rwanda (Nzeyimana *et al.,* 2015).

In Ethiopia, prevalence of *C. bovis* in cattle population of different regions was conducted by meat inspection survey in abattoirs. It showed that *C. bovis* was prevalent and widespread throughout the country with national average of 13.7%. However, the prevalence distribution varied from place to place (Table 1).

Public Health Importance

Man is the only final host where the adult *Taenia saginata* resides in the small intestine. The size reached by the adult worm is related to the number of worms present (Parija, 2022). In a single worm infection, a worm can develop longer and produce large number of proglottids (Smith, 1994). Multiple infections up to 20 tapeworms in one host are often occurring in developing countries (Mann, 1984). Oncospheres have been found in finger nails; dirty water transmission is accomplished by the contamination of pasture, fodder and water with egg

(WHO, 1983). Multiple signs are caused by taeniasis, and these likely rely heavily on the host's physical and mental traits. While some patients survive the infection, others lose weight as a result of their decreased appetite. Most cysts stay viable and infectious for one to two years after developing for three to five months. A man contracts the infection by eating raw or properly cooked beef that contains a live cyst (Lightowlers, 2003; Parija, 2022).

Economic Impact

The cost implication can be broken down in to those involved in treating human *teaniasis* and cattle carcasses (cost of freezing, boiling) or condemnation, as well as the costs involved in the inspection procedures amount to millions of dollars (Mann, 1984). Annual losses due to treatment in USA were US$ 100,000 (Robert, 1995), in south Africa US$ 428 million (Fan, 1997). In Ethiopia there is a wide usage of both traditional and modern taeniacidal drugs (Fesseha, 1995; Alemneh and Adem, 2017), which is an indication of the economic importance of the drugs in each house hold. The total dose of niclosamide and diclorphene production in two drug factories in this country between 1996 and 2000 was 31,814,833 Ethiopian birr. The annual expenditure for the modern drug in three selected areas of Shoa (Akaki, DebreZeit and Nazareth) was estimated to be 1,471,281 Ethiopian birr during the year 2000 (Tembo, 2001). Similarly, the four years expenditure, from 2010 to 2013, for the modern drug in Bishoftu was 384,198.97 Ethiopian birr (Geinoro and Bedore, 2019).

Clinical Signs

In human

Taenia saginata like all other human helminthes may provoke symptoms or may not reveal symptoms. The most frequently observed symptom of *T. saginata* infection is the discharge of proglottids. In addition to this, some infected individuals may show abdominal pain, nausea, weakness, losses of weight, increased appetite, headache, constipation, dizziness, diarrhea, pruritis and excitation (Parija, 2022).

In cattle

Under natural conditions, the presence of *cysticerci* in the muscle of cattle is not associated with clinical signs (Urquhart *et al.,* 1996). However, 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).

Diagnosis

In human

In human beings, the diagnosis is established by examination of the eggs in the stools or gross examination of the proglottids or segments passed in the stool (Ghai, 2000). Diagnosis is based on symptoms, faecal examination and rectal swabs, although it is difficult to discover the disease during the first 3 months. A person should not be considered uninfected before having three negative tests completed over a 2-3 day intervals (OIE, 2004). However, the exact species identification of *T. saginata* is made by examination of the scolex or proglottids that show typical species characteristics (Pawlowski and Schultz, 1972; Smyth, 1994).

In cattle

Diagnosis of cysticercosis in bovine is usually made by post-mortem examination. i.e. by observation of the cysts. The diagnosis of bovine *cysticercosis* in many countries is mainly based on carcass inspection through incision of master, tongue, heart, triceps; intercostals muscles and the diaphragm (Urquhart *et al.,* 1996; Jansen *et al.,* 2018). Many different serological tests have also been introduced in order to replace the current “knife and eye” method of diagnosis at the slaughter house, which detects only a small fraction of cattle infected with cysticerci (Greerts *et al.,* 1992; WHO, 2005).

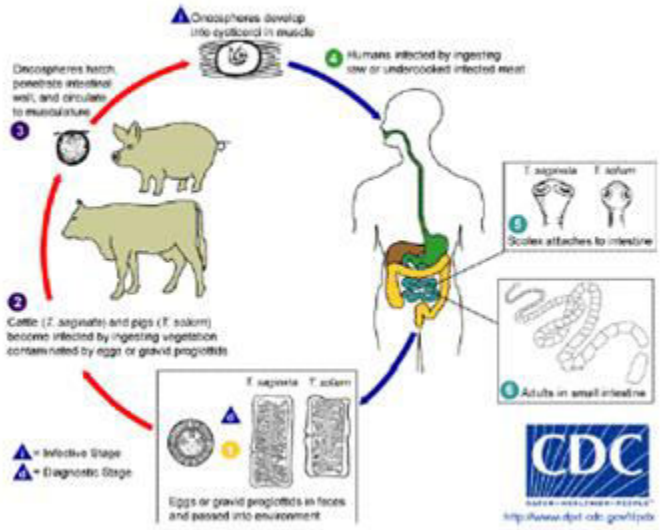
Treatment

The most widely used systemic drugs for the treatment of *T. saginata* in Ethiopia are Neclosamide and paraziquantel. 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 (Zhang and Zheng, 2019) but the scolex is partially digested and often not recovered (Symth, 1994; Zhang and Zheng, 2019).

Table.1 Prevalence of *cysticercosis* in Ethiopia

Sr.No.	Study areas	Species	Prevalence (%)	References
1	Gondar	Bovine	2.99	Motbaynor and Terefe, 2015
2	Jimma	Bovine	2.34	Derbew and Mohammed, 2022
3	Wolaita Sodo	Bovine	2.59	Tesfaye *et al*., 2020
4	Kombolcha Elfora	Bovine	6.4	Engdaw *et al*., 2015
5	Bishoftu	Bovine	4.24	Fesseha and Asefa, 2023
6	Nekemte	Bovine	2.89	Shuramo *et al*., 2022
7	East shoa	Bovine	17.5	Hailu, 2005
8	West Hararghe	Bovine	20.27	Shafi and Elemo, 2022
9	Addis Ababa	Bovine	2.8	Mohamed *et al*., 2021
10	Hawassa	Bovine	1.3	Mulugeta *et al*., 2024
11	Dilla	Bovine	4.25	Tesfaye *et al*., 2020
12	Silte	Bovine	36	Mussa, 2023

Figure.1 Life cycle of *Taenia saginata*



Other drugs used in the treatment of *T. saginata* are mebendazole (Soulsby, 1982). In Ethiopia, the majority of the rural inhabitants use traditional herbal dugs in routine self-deworming as a taenicidal herb, as has been topic for researches in Ethiopia (Desta, 1995; Feseha, 1995; Alemneh and Adem, 2017).

Prevention and Control Strategies

Strategies for prevention and control should focus on preventing or lowering the risk factors linked to the spread of cysticercosis and taeniasis. Taeniasis and cysticercosis are controlled by diagnosing and treating Taenia carriers, educating the public about the importance of using latrines, preventing raw meat contamination, testing cattle for *C. bovis*, and inspecting carcasses after death (Cabaret *et al.,* 2002; Wanzala *et al.,* 2003; Blagojevic *et al.,* 2017).

Generally, *T. saginata* taeniasis and bovine cysticercosis can be easily controlled by cooking meat at 560C or by freezing carcasses at -180C for 5 days, or at -100C for 10 days (Urquhart *et al.,* 1996). The main mechanism of immunity to taeniids is antibody-mediated. There have been reports of the development of extremely effective vaccines that work well in both laboratory and field

settings to prevent cattle from contracting cysticercosis, which is caused by *T. saginata* (Lightowlers, 2003; Peón *et al.,* 2016; Uchendu and Fana, 2023).

Conclusion and Recommendations

One of the most common parasite infections in sub-Saharan Africa is bovine cysticercosis, or *Taenia saginata*. It is more common in countries with lower incomes, particularly Ethiopia, where people customarily eat raw, inadequately cooked, or sun-cured meat and sanitary standards are poor. Raw meat consumption, outside defecation, inadequate waste management, a lack of public knowledge, and backyard abattoir practices were the variables linked to the illness. In addition to its zoonotic significance, taeniosis/cysticercosis results in economic losses due to the rejection of whole carcasses and edible offal and the expense of treating infected humans. Thus, regular meat inspections, raising public awareness of the need to improve environmental and personal hygiene, and educating schoolchildren about the risks of eating raw meat are all effective ways to transform the nation's culture. To create a clear epidemiological picture of the disease's prevalence and economic significance, further research on the prevalence and public health significance of bovine cysticercosis should be promoted.

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