

Prevalence and public health importance of bovine cysticercosis in and around Dessie, Amhara region, North East Ethiopia

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Target Audience: Beef producers, Veterinarians, Epidemiologists, Animal scientists and Public health experts.

Abstract

A cross sectional study was conducted between November 2018 to April 2019 to estimate the prevalence and public health importance of bovine cysticercosis in and around Dessie town, Amhara region, North East Ethiopia. Data were collected from active abattoir and through questionnaire survey. Out of 384 carcasses examined, 37 (9.6%) were found to be infected with *Cysticercus bovis*. Cyst prevalence per organs was 5.5% (21) in liver, 2.1% (8) tongue, 1.0% (4) masseter muscle, 1.0% (4) heart and 0.5% (2) brachial muscle. Bovine cysticercosis was found to be 16 (14.2%) in medium, 10 (11.8%) good and 11 (5.9%) poor body condition cattle. Of the total 144 *C. bovis* cysts detected, 68 (47.22%) were found to be alive. Of the total 80 interviewed respondents, 18 (22.5%) had contracted *Taenia saginata* infection. The prevalence was 35.7% in males and 15.4% in females, 42.9% in government employees. Human taeniasis prevalence showed significant ($p < 0.05$) differences with age groups, sexes and occupation but no significant ($p > 0.05$) difference was recorded between marital status, religion, education level, latrine availability and meat consumption habit of respondents. The study revealed the presence of bovine cysticercosis and its public health hazards need increased awareness of the health impact of taeniasis to safeguard the community.

Keywords: Bovine; Cysticercosis; Dessie; *Taenia saginata*; Prevalence; Public health

Description of Problem

Animal health, mainly cattle is one of great economic importance, which is considered the key source of meat, milk and hides in Ethiopia. Such meat is the most common animal protein for human consumption. Animal diseases are one of the most important constraints to increase productivity of food animals in all parts of the world. Parasitism is one of the major problems that affect the productivity of livestock (1).

Bovine Cysticercosis is one that remains a major public and animal health problem (2). It is a parasitic infection of cattle caused by the larval stage (cysticercus) of the cestode, *Taenia saginata*. This larva is meat-borne and human infection results from the ingestion of raw or undercooked beef (3). Bovine cysticercosis is a disease that affects the musculature of cattle and is caused by the metacestode stage of human intestinal cestode and *Taenia saginata* (4).

All ages of cattle are susceptible to this parasite with young age groups being more susceptible than the others. Taeniasis is one of the major parasitic diseases transmitted by eating raw or undercooked meat infected with cyst stage of these parasites. It does not only lead to economic losses, but also adversely affect the public health (5).

Both adult and larval forms of *Taenia saginata* harmfully affect health of their separate hosts, either directly or indirectly with several secondary infections particularly in humans. The existence of metacystode larval stage of *C. bovis* in cattle musculature is causing bovine cysticercosis while the adult stage of worm in human small intestine is characterized by Taeniasis (6). Cysts of *C. bovis* can be found anywhere in the carcass and viscera, but its illustrated sites are predilection like masseter, tongue, heart, triceps, intercostal muscles and the diaphragm which organs are consumed at raw level and causes of public health hazards (5).

Poor hygiene, primitive livestock husbandry practice and inadequate meat inspection management and control policy are the transmission agents of the parasite (7). *Taenia* eggs passed in the faeces or discharge 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 (8).

Cattle acquire the infection through the ingestion of eggs. The cysticerci or larval stage

is formed over a period of 3-4 months, after egg is ingested by intermediate host and may be viable in the intermediate host for up to 9 months or even up to the entire life of the host. They are contained in a thin, host-produced fibrous capsule (8, 9). In the bovine animal, the mature cysticercus is grayish white, small, pea-sized, oval, about 0.5 cm-1.0x0.5 cm long, and filled with fluid in which the scolex is usually clearly visible (4)

Taenia saginata occurs where cattle are raised in an area where a human faeces is improperly disposed-off, meat inspection programs are poor and meat is eaten without proper cooking (2). Geographical distribution and status of the Taeniasis is considered as serious in the developing countries but less recognized for public health problems. Bovine cysticercosis is cosmopolitan in distribution and is very common in Africa (10). It is highly endemic in areas of Central and East African countries like Ethiopia, Kenya and Zaire (11).

The custom of eating undercooked beef dishes such as: 'kourt', 'lebleb', 'kitfo' and the habit of defecating in open fields coupled with the tradition of allowing cattle to graze in fields made cysticercosis of cattle and taeniasis of human common in Ethiopia. A high occurrence of human infection in different agro-climatic zones of the country has been reported (12). Among the prevalent livestock diseases, zoonotic ones are the major constraint to the development of livestock productivity in Ethiopia. Bovine cysticercosis is a zoonotic disease that remains a major public health problem in lower income and some industrialized countries (13).

Taenia saginata in small intestine of humans absorbs digested food and its proglottids migrate to different organs causing different signs (14). Adult *T. saginata* can live up to 30 to 40 years in the small intestine of its

human host. Most humans who carry an adult tapeworm are asymptomatic. Patients may intermittently pass proglottids either in their stool (*Taenia solium*) or spontaneously (*Taenia saginata*) (10).

Generally insufficient health education and low availability of taenicides are the major hindrances for the control infections in Ethiopia (6). In foreign trade, Ethiopia is placed to export live animals to the Middle East, North and West Africa. Therefore, *Taenia saginata* transmission is a major public and animal health problem (15). The study was therefore aimed at estimating the prevalence and public health importance of bovine cysticercosis in and around Dessie town, Amhara region, North East Ethiopia.

Materials and Methods

Study area and period

The study was conducted from November 2018 to April 2019 in and around Dessie city administration. Dessie is located at North East Ethiopia at a distance of 400km from Addis Ababa, at latitude 11°08'N and longitude 39°38'E. It has an elevation of 2600 m above sea level. The mean minimum and maximum temperature of the area are 12.37°C and 26.27°C, respectively. The livestock population of the area is 49618 (i.e.: 18,724 cattle, 22,248 sheep, 2,572 goats, 1,879 horses, 833 mules, 3,362 donkeys) and 37,557 chickens (16).

Study population

The study animals were local and cross breeds of cattle presented for slaughter from those animals which were daily brought to the Dessie Municipal Abattoir (from Dessie and its surrounding areas mainly from Kutaber, Hayk, Kombolcha, Kemissie and others). Volunteer participants in and around Dessie town were

used for questionnaire surveys. They were drawn from different social groups like, farmers, students, merchants, and government employers.

Sampling and sample size determination

Simple random sampling method was employed for selecting animals from cattle slaughtered in Dessie Municipal Abattoir during the study period. To calculate the total sample size, the following parameters were used: 95% confidence level, 5% desired level of precision and 50% expected prevalence of bovine cysticercosis among cattle in the study area since there was no previous work in the study area, and the formula given by Thrusfield (17) was used.

$$n = \frac{1.962P_{exp}(1-P_{exp})}{d^2}$$

Where, n= required sample size; P_{exp} = expected prevalence (50%); d= desired absolute precision (0.05). Accordingly, $n = 1.962 \times 0.5 (1 - 0.50)/0.0025 = 384$ Cattle were sampled.

Data collection procedures

Ante-mortem examination, post-mortem examination and cyst evaluation (viability test)

Ante-mortem examination was conducted on randomly selected 384 cattle for the presence of disease or abnormality before they were slaughtered. Age, sex, breed, and body condition of each randomly selected animal were assessed and recorded. The animals were slaughtered and checked for the presence of *C. bovis*. The post mortem inspection was carried out according to the guideline by Ministry of Agriculture (18). The examination was conducted through visualization, palpation and two 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, deep incision into external and internal muscles of the masseter parallel to the plane of the jaw, longitudinal incision of the heart from base to apex, three parallel incisions into the long axes of the neck muscles on both sides as well as one extensive incisions on the diaphragm; visual examination, palpation and incision of liver and kidneys. Findings were registered according to the organs inspected.

The cyst found during meat inspection was removed with the surrounding tissue and taken to Kombelcha regional veterinary parasitology laboratory for viability test. The viability of the cyst were examined by placing them in 40% ox-bile solution diluted in a normal saline and incubated at 37°C for 1 to 2 hrs. A cyst was regarded as viable if the scolex evaginated during the incubation period. *Taenia saginata* metacestodes were identified by the cysticercus size, presence of a rostellum and absence of hooks on the rostellum of the evaginated cyst (19).

Questionnaire survey on human taeniasis

Questionnaire survey on human taeniasis occurrence and its associated factors was administered on 80 randomly selected volunteer respondents from Dessie town and adjoining areas from whom pre-informed consents were obtained. The predisposing factors of taeniasis such as age, sex, religion, occupation, educational levels (illiterate, primary school, secondary school, preparatory stage, college and university), habit of raw meat consumption, presence and usage of sanitary facilities especially toilet and knowledge of *Taenia saginata* were assessed. Following detailed discussion on the objectives of the study with each participant, the interview was conducted face to face.

Data analysis

The data collected from the active abattoir and questionnaire surveys were analyzed using STATA version-13. The outcome variables for the abattoir study were cases of *C. bovis* detected during routine postmortem inspection. The association between the factors and bovine taeniasis was assessed using Pearson's Chi-square (χ^2) test. The findings of the questionnaire survey data were summarized using descriptive analysis and important factors were tested with chi-square (χ^2) test for their association with the occurrence of taeniasis in human at 5% alpha level of significance.

Results and Discussion

Abattoir survey

Out of 384 bovines inspected, 37 were found to be positive for *C. bovis* at postmortem inspection with over all prevalence of 9.6% (Table1). This is slightly in agreement with a previous study conducted in Kombolcha with a prevalence of 6.7% reported by Endris and Negussie (20), in Halaba with a prevalence of 8.6% studied by Abdulaziz *et al.*(21), Kombolcha in north eastern Ethiopia (8.9%) reported by Tegegne *et al.*(22), and in Wolita Sodo (11.3%) reported by Regassa *et al.*(23). The present result was slightly higher than that found in Ziway (3.0%) Bedu *et al.* (24), in Debreberhan (4.6%) Kifle and Shiret (25), in Jimma (2.9%) Megerssa *et al.* (26), but result lower than the current study found in Hawassa (26.3%) Abunna *et al.* (27), Addis Ababa (89.4%) Tembo (12), and in North Western Ethiopia (18.5%) Kebede (28). The reason for the difference in the prevalence of bovine cysticercosis might be due to many reasons such as time of occurrence (in the dry season higher than rain season), status of the people in the environment (keeping personal and environmental hygiene decreases the

prevalence of the parasites), practical limitation of the number of incisions made during inspection and inspection ability of the researchers (29). Generally, the method of meat inspection, the ability of meat inspector

to identify the cysts, difference in animal management, sample size and sampling method and the number of incisions can contribute for the variation of the prevalence of bovine cysticercosis.

Table 1: Occurrence of Bovine cysticercosis with respect to sex, age, origin and body condition of the animals, N=384.

Risk factors	Categories	No. examined	No. infested (%)	χ^2	P-value
Sex	Male	303	29(9.6)	0.007	0.934
	Female	81	8(9.9)		
Age in years	≤5	196	19(9.7)	0.543	0.762
	6-7	175	16(9.1)		
	≥8	13	2(15.4)		
Origin	Gerado	9	0(0.0)	11.790	0.225
	Haik	53	3(5.7)		
	Kemissie	27	1(3.7)		
	Kutaber	45	2(4.4)		
	Harbu	71	6(8.5)		
	Komebelcha	96	12(12.5)		
	Weldeya	19	3(15.8)		
	Dessie	46	7(15.2)		
	Degan	12	1(8.3)		
	Ambasel	6	2(33.3)		
Body score condition	Good	83	10(11.8)	6.057	.048
	Medium	115	16(14.2)		
	Poor	186	11(5.9)		

In this study, burden of bovine cysticercosis didn't vary significantly between different sexes, ages and the origins of the animals ($p>0.05$) (Table 1). In the case of age and origin agrees with the study reported by other authors (12, 23, 30, and 31). In the case of age this was also agrees with report of Nuraddis and Frew (32) but contrary with the report of Mesfin and Nuraddis (33). One possible explanation for this variation might be due to the fact that any age group of animals has similar susceptibility to *T. saginata* egg and most of the animals slaughtered in this abattoir were adult and have similar management systems.

In this study, although more males than females were examined there was no significant difference ($p>0.05$) in the occurrence of bovine cysticercosis between the sex of animals (Table 1). This was in agreement with report of Gomol *et al.*, (34) in Jimma, Kebede *et al.* (35) in Addis Ababa, and Jemal and Haileleul (36) in Kombolcha, but contrary with the report of Abdulaziz *et al.*, (21) in halaba kulito, Tegegne *et al* (22) in Kombolcha, Kifle and Shiret (25) in Debreberhan. The possible reason for this variation of significant among different studies might be the sample size variation between female (n=81) and male (n=303) cattle slaughtered at different municipal abattoirs.

Table 2: Occurrence of *C. bovis* in different body organs of the study animals, N=384

Organs inspected	Number of positive (frequencies)	Prevalence (%)
Heart	4	1.0
Liver	21	5.5
Tongue	8	2.1
Masseter muscle	4	1.1
Brachial muscle	2	0.5
Triceps muscle	0	0.0

Table 3: Proportion of viable cyst in different organs inspected, N=384.

Organs	Number of cyst	Viable cyst	Proportion of Viable cysts (%)
Heart	22	13	59.1
Liver	68	29	42.6
Tongue	28	17	60.7
Masseter muscle	17	9	52.9
Brachial muscle	9	4	44.4
Triceps muscle	0	0	0.0
Total (n)	144	68	47.2

There was significant difference ($p < 0.05$) between body condition of the study animals towards the occurrence of bovine cysticercosis (Table 1). Higher prevalence was recorded in animals that have medium body condition (14.2%) than good body condition cattle (11.8%). This finding was higher than the study reported by Addisu and Wondimu (30) (good=1.9% and medium=5.8%) but lower than the report of Mesfin and Nuraddis (33) (good=22.0% and medium=24.0%) but agreed with the report of Abdulaziz *et al.*, (21) (good=7.0% and medium=15.9%). The reason behind low prevalence in good body condition than medium body condition might be due to the fact that most of the animals slaughtered in the abattoir were brought from fattening systems of the individual farmer, in which

animals from such farms were less exposed to eggs of *T. saginata* as they graze on relatively clean defined pasture land; tying system to the pegs and intensive feeding system in the house for fattening purpose and use of anthelmintic drugs.

With regard to the origin of animals, the highest prevalence was observed from cattle of Ambasel 33.3% followed by Weldeya 15.8%, Dessie 15.2%, Kombelcha 12.5%, Harbu 8.5%, Degan 8.3%, Haik 5.7%, Kutaber 4.4%, Kemissie 3.7%, and Gerado with 0.0% prevalence (Table 1). This variation of prevalence could be associated with their geographical differences and likely associated with the number of animals brought to the abattoir.

Table 4: Infection of human taeniasis on the basis of sex, age, marital status, religion and level of education, N=80.

Risk factors	Respondents	Interviewed	Suffered (%)	χ^2	p-value
Sex	Male	28	10(35.7)	4.3137	0.038
	Female	52	8(15.4)		
Age	14-29	52	6(11.5)	11.330	0.010
	30-45	12	4(33.3)		
	46-57	6	3(50.0)		
	≥58	10	5(50.0)		
Marital status	Married	39	12(30.8)	2.984	0.084
	Unmarried	41	6(14.6)		
Religion	Muslim	38	10(26.3)	0.714	0.700
	Orthodox	35	7(20.0)		
	Other	7	1(14.3)		
Level of Education	Illiterate	10	2(20.0)	4.296	0.231
	Primary school	17	6(35.3)		
	Secondary and prep.	25	7(28.0)		
	College and university	28	3(10.7)		

Table 5: Infection of human taeniasis on the basis of occupation, residence, meat consumption habit, carcass source and latrine availability, N=80.

Risk factors	Respondents	Interviewed	Suffered (%)	χ^2	p-value
Occupation	Gov. Employee	7	3(42.9)	10.837	0.028
	Farmer	21	8(38.1)		
	Merchant	5	2(40.0)		
	Student	31	5(16.1)		
	Priv. employee	16	0(0.0)		
Residence	Rural	49	8(16.3)	2.764	0.096
	Urban	31	10(32.3)		
Meat consumption habit	Partially cooked	7	2(28.6)	2.365	0.306
	Raw	21	7(33.3)		
	Well-cooked	52	9(17.3)		
Carcass source	Traditionally	35	9(25.7)	1.232	0.745
	Owner slaughter	14	4(28.6)		
	From abattoir	13	2(15.4)		
	Local butchers	18	3(16.7)		
Latrine availability	Absent	11	4(36.4)	1.406	0.236
	Present	69	14(20.3)		

Anatomical distribution of cysts

Active abattoir survey revealed that there was variation in the anatomical distributions of *C. bovis* in organs of inspected cattle. The

most frequently affected organ with the highest number of cysts was the liver (5.5%) followed by tongue (2.1%), heart (1.0%) and masseter (1.0%), brachial (0.5%) and triceps (0.0%)

muscles (Table 2) this finding agreed with Tegegne *et al.*, (22) reported in liver. This finding was disagreement with the finding of Abdulaziz *et al.*, (21) reported in diaphragm, Addisu and Wondimu, (30) reported in tongue, Kifle and Shiret (25) reported in triceps muscle, Regassa *et al.*, (23) reported in heart, Nuraddis and Frew, (32) reported in triceps muscle and Mesfin and Nuraddis, (33) reported in tongue. The reason behind, these variations of anatomical distribution of cyst might be due to a number of factors, such as blood kinetics and animal's daily activities. Any geographical and environmental factors affecting blood kinetics and meat inspector preferential for predilection sites during meat inspection in the animal affect the distribution the cysts in different organs of the host (37). Moreover, these organs usually consumed raw or undercooked that could pose public health hazard in contracting taeniasis (27).

Cyst viability test

A total of 144 cysts were detected during the inspection. Of the total 144 *C.bovis* collected during the study period 68(47.2%) were found to be a live while other 76(52.8%) were degenerative cyst (Table 3). Viability test of the cysts revealed that it was the tongue which harbored the highest number of viable cysts (60.7%) followed by Heart (59.1%), Masseter muscle (52.9%), Brachial muscle (44.4%), Liver (42.6%) and Triceps (0.0%). However, the present finding was less than the findings of Lielt *et al.* (37) and Dejene *et al.* (38). It was also greater than the finding of Bekele *et al.* (39) (42.9%). Generally, the method of meat inspection, the ability of the meat inspector to identify the cases, difference in the management, sample size and sampling method, the number of cuts, and other factors can contribute for the variation of prevalence

of bovine cysticercosis.

Questionnaire survey result of *T.saginata* taeniasis

Of the total 80 voluntary respondents interviewed, 18(22.5%) of them said they were infected with *T. saginata* at least once in their life time. This human taeniasis prevalence (22.5%) demonstrates the importance of taeniasis in Dessie town and its adjoining areas. This finding agreed with the result of Abdulaziz *et al.* (21) in Halaba Kulito (19.0%), but the current result was less than the results of Abunna *et al.* (27) in Awassa town (64.2%), Terefe *et al.* (41) in Harari (60.7%), Tegegne *et al.*(22) in Kombelcha (33.8%), Regassa *et al.* (23) in Jimma (56.7%), Endris and Negussie, (20) in Kombolcha (31%), Dawit *et al.* (42) in Wolaita sodd (62.5%) and Regassa *et al.* (23) in Wolaita sodd (50.6%). This variation of human taeniasis in different areas might be associated with the difference in occurrence of cysticercosis in cattle, the level of raw meat eating culture among societies, the meat inspection procedures and backyard slaughtering practices.

In this study, the prevalence of *T. saginata* was found significantly different between different sex of respondents ($p<0.05$). Females (15.4%) were less affected compared to male (35.7%) respondents (Table 4). This finding agreed with that of Lielt *et al.*, (37) in Bishoftu, but disagreed with the reports of Kifle and Shiret (25) in Debrebrhan, Abdulaziz *et al.*, (21) in Halaba Kulito, Dawit *et al.*, (42) in Wolaita Sodd and Tegegne *et al.*, (22) in Kombelcha. This higher prevalence in males could be due to the habit of males consume frequently raw beef at outdoor than females in the study area leading to higher exposure of *C. bovis* and males usually consume raw meat more often than females while practicing

backyard slaughtering.

The present study also revealed that the prevalence of *T. saginata* was significantly associated with different age groups of respondents ($p < 0.05$). The aged groups 46-57 and above 58 years old respondents (50.0%) followed by the age group of 30-45 years (33.3%) had relatively higher infection rates compared to those respondents between the age group of 14-29 years (11.5%) (Table 4). This agreed with that of Lielt *et al.*, (37) in Bishoftu, Dawit *et al.*, (42) in Wolaita Soddo and Kifle and Shiret (25) in Debrebrhan. But, this study disagreed with that report of Tegegne *et al.*, (22) in Kombolcha. This could be explained by the fact that elderly have higher chance to consume *C. bovis* infected raw meat in different occasions including cultural ceremonies where raw meat is served as one of the major food items while younger, in generally, have no such access.

The study revealed that occupation of the respondents had significant association with that of taeniasis ($p < 0.05$). This result agreed with that reported of Kifle and Shiret, (25) in Debrebrhan, Lielt *et al.*, (37) in Bishoftu. But, disagreed with the report of Abdulaziz *et al.*, (21) in Halaba Kulito. The prevalence of *T. saginata* was higher in governmental employers (42.9%) followed by merchant (40.0%), farmers (38.1%), students (16.1%) and Private employee (0.0%) (Table 5). This is due to the fact that the high exposed groups have higher access to contact with meat and meat byproducts. As a result of this there could be a possibility of getting infection with *T. saginata*.

In this study there was no statistically significance difference between proportions of taeniasis in different educational levels, occupation, residence, latrine availability, marital status, religion and meat consumption

habit (Table 4 and 5). Previous reports from Ethiopia indicated that consumption of raw or inadequately cooked beef was strongly associated with *T. saginata* infection. In this study from 21 respondents who ate raw or inadequately cooked beef 7(33.3%) acquired *T. saginata*, confirming that 'kurt, kitffo and dullet' are all sources of viable cysts of the parasite, as found in previous studies (20, 24, 26 and 27). It is therefore good to focus strongly on those edible parts of the carcass used for the preparation of these traditional dishes during meat inspection and public education.

In case of educational level similar findings were reported in other studies in different year (26, 30) and indicating insignificant infection rate among the various educational statuses. However, disagreed with studies reported in Hawassa town (33) and in Southwest Shoa zone of Oromia Region (43). This could be due to the long-time cultural habit of eating raw meat particularly that of 'kurt' and 'kitifo' in any social groups including those of the educated and even in the medical and veterinary professionals.

Conclusion and Applications

1. Bovine cysticercosis is an important zoonotic disease.
2. The occurrence of the disease both in human and animals is high and poor slaughter processes and meat handling and processing seem to aggravate the situation.
3. Both the abattoir and the questionnaire surveys showed that bovine cysticercosis was important parasitic disease in Dessie and adjoining areas in terms of its public health implications.
4. Animal organ distribution of the cyst incurred a health risk from a public health

- point of view.
5. Variable knowledge by community of the associated risk shows the need for community education as awareness creation regarding the disease condition, consumption of raw meat, application of environmental hygiene and other associated risk factors to minimize the impact of *Taenia saginata*/bovine cysticercosis in the study area. Therefore; based on the above conclusion, the following applicable strategic points were recommended:
 1. Awareness should be created in the public with regard to the zoonotic importance of bovine cysticercosis and the risk of raw meat consumption to taeniasis.
 2. Strict routine meat inspection of slaughtered animals should be carried out.
 3. The community should be intensively encouraged for construction of simple toilet to minimize contamination of pasture with human stool, so that the cycle of *T. saginata* interrupted.
 4. Moreover, close integration between medical and veterinary service is reliable to reduce the impact of the taeniasis in both human and cattle population in Dessie and its adjoining area.

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