

Full Length Research Paper

Prevalence, financial impact and public health significance of *Cysticercus bovis* at Bahir Dar Municipal Abattoir, Ethiopia

Birhanu Tamirat^{1*}, Habtamu Tamirat¹ and Mu-uz Gebru²¹College of Veterinary Medicine, Mekelle University, Mekelle, Ethiopia. P. O. Box 2084, Ethiopia.²College of Agriculture and Environmental Science, Bahir Dar University, Bahir Dar, Ethiopia.

Received 28 September, 2017; Accepted 1 November, 2017

A cross-sectional study was conducted from November 2016 to April 2017 to determine the prevalence of cysticercosis, assess the associated risk factors and public health importance of human taeniasis at Bahir Dar municipal abattoir, Bahir Dar town. Active abattoir survey from local zebu cattle presented to Bahir Dar abattoir and questionnaire surveys data collected were analyzed using SPSS version 20. Out of 480 inspected animals, 20 animals had varying number of *Cysticercus bovis* with prevalence of 4.2% (20/480). Cyst distribution per organs were; tongue 12/20 (2.5%), shoulder 10/20 (2.08%), masseter muscle 7/20 (1.46%), heart 4/20 (0.8%) and liver 1/20 (0.21%). From the total number of 119 *C. bovis* collected from the infected 20 cattle during the study period, 73 (61.3%) were found to be alive while the rest 46 (38.7%) were degenerative cysts. Cysticercosis prevalence showed that there was no statistically difference among age groups and body condition score with the occurrence of *C. bovis* ($p > 0.05$). Of the total 69 interviewed respondents, 30.4% (21/69) had contracted *Taenia saginata* infection. The prevalence of taeniosis showed significant difference ($p < 0.05$) with age groups, habit of raw meat consumption, toilet availability, sex and religion. However, there was no significance difference between marital status, educational level, knowledge of taeniasis and occupational risks ($p > 0.05$). The findings of this study indicated the importance of bovine cysticercosis and taeniosis in the study area. Therefore, attention should be given to the public awareness and routine meat inspection to be safe to public health and promote meat industry in the country

Key words: Abattoir, Bahir dar, *Cysticercus bovis*, prevalence, public health.

INTRODUCTION

Taenia saginata is a worldwide zoonotic cestode whose epidemiology is ethnically and culturally determined with estimation of 50-77 million cases of infestation worldwide with 50, 000 people dying from this problem annually. Both the adult and larvae formed hazardously affect the

health of their respective hosts, either directly or indirectly, accompanied with several secondary infections, particularly in human hosts. The occurrence of larvae of *Cysticercus bovis* in cattle musculature causes cysticercosis while the adult worms in human small

*Corresponding author. E-mail: birhanutamirat606@gmail.com. Tel: +251-918597622.

intestine cause taeniasis (Minozzo et al., 2002).

There are a number of zoonotic diseases that can be transmitted from animal to humans in various ways. Wide varieties of animal species, both domestic and wild, act as reservoirs for these pathogens (viruses, bacteria or parasites) which may be transmitted to humans (Sumbria et al., 2016). Given the extend of distribution of the animal species involved and the ineffective surveillance, prevention and control of zoonotic diseases pose a significant challenge (Meslin et al., (2000).

In the past, zoonotic diseases were limited to populations living in low- and middle-income countries, but the geographical limits and populations at risk are expanding and changing because of increasing international markets, improved transportation systems, and demographic changes (Chhabra and Singla, 2009). Most parasitic zoonoses are neglected diseases despite causing a considerable global burden of ill health in humans and having a substantial financial burden on livestock industries. Although the global burden for most parasitic zoonoses is not yet known, the major contributors to the global burden of parasitic zoonoses are toxoplasmosis, food borne trematode infections, cysticercosis, echinococcosis, leishmaniasis and zoonotic schistosomiasis (Torgerson and Macpherson, 2011; Singla, 2012; Chhabra and Singla, 2014). Parasitic diseases are highly prevalent in Sub-Saharan Africa and incur severe economic losses by reducing productivity. *Taenia saginata* taeniasis / bovine cysticercosis is one of the major parasitic diseases, which does not only lead to economic losses, but also adversely affect public health.

Meat-borne diseases are common in developing countries including Ethiopia because of the prevailing poor meat handling, sanitation practices, inadequate food safety laws and lack of education for food-handlers (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 East African countries, prevalence rates of 30-80% have been recorded (Tembo, 2001). In developing countries, the incidence of human infection with *T. saginata* is usually high, with the prevalence of over 20 %; whereas in developed countries, the prevalence of cysticercosis is low, usually less than 1% (Urquhart et al., 1996).

In Ethiopia several authors have reported the prevalence of *T. saginata* taeniasis and cysticercosis with in a wide range of 2.5 to 89.41% and 3.11 to 27.6% prevalence, respectively (Dawit, 2004; Hailu, 2005; Abunna et al., 2008).

The problem of food borne parasitic zoonosis could be further complicated in Ethiopia by lack of efficient inspection at critical control points in abattoirs, lack of awareness and knowledge on the mode of transmission and public health hazard of these diseases as well as due to presence of widespread habit of raw meat consumption both in rural and urban communities. A

number of reports in Ethiopia indicated that, certain groups who had easy access to raw meat and meat products and those people with low level of formal education were reported to be more infected with meat parasitic zoonosis than those who had low access to raw and those with better education (Tadesse et al., 2012). This study aimed at determining the prevalence of *C. bovis* in cattle slaughtered at Bahirdar municipal abattoir, identify risk factors associated with cysticercosis and taeniasis and to estimate the prevalence of human taeniasis / *T. saginata* in the area.

MATERIALS AND METHODS

Study area

The study was conducted at Bahir Dar, the capital city of Amhara Regional State, located at 11°29'N latitude, 37°29'E longitude at about 565 km North-West of Addis Ababa from November 2016 to April 2017.

The altitude of the area is 1830 meter above sea level and has average annual rainfall of 1500 mm. The mean annual temperature of the study area is 23°C. Lake Tana and River Abay influence the climatic condition of the study area. The area has a mixed farming practice with crop and livestock production (Bard, 2009). Based on the Census conducted by the Central Statistical Agency of Ethiopia (CSA), Bahir Dar Special Zone has a total population of 221,991, of whom 108,456 are men and 113,535 women; 180,174 or 81.16% are urban inhabitants, the rest of population are living at rural kebeles around Bahir Dar (CSA, 2007).

Study population and study design

The study was a cross-sectional type in which a structured questionnaire survey and active abattoir survey was conducted. Animal study populations were cattle presented to Bahir Dar municipal abattoir for slaughtering. All cattle were local oxen that originated from Bahir Dar, Adet, Debre tabor and Este areas brought by the merchants. For human study population, residents of Bahir Dar town, were subjected to questionnaire surveys. The recruitment of volunteer individuals in the study was not based by age, sex, marital status, habit of raw meat consumption, education level and religion.

Sample size determination

The sample size was determined following the formula published in using the expected prevalence of bovine cysticercosis in Bahir Dar (19.4%) reported with 95% confidence interval at a desired absolute precision of 5%. Therefore, the required sample size was calculated according to the formula (Thrusfield, 2007 and Mulugeta, 1997):

$$N = \frac{1.96^2 P_{exp} (1 - P_{exp})}{d^2}$$

Where, N = required sample size, P exp= expected prevalence, d = desired absolute precision and $N = 1.96^2 \times 0.194(1-0.194) / (0.05)^2 = 240$ animals.

However, to increase the level of accuracy of prevalence determination, 480 animals were sampled and inspected during the

study period for the presence of *C. bovis* cyst in different organs.

Sampling procedures

Active abattoir survey

The cross sectional study was conducted during meat inspection on randomly selected 480 cattle slaughtered at Bahir Dar municipal abattoir. Before slaughter, ante-mortem inspection was carried out and the tag number of each animal was recorded. According to the guideline (Ministry of Agriculture, 1972) for masseter muscle, deep linear incisions were made parallel to the mandible; the heart were incised from base to apex to open the pericardium and incise also made in the cardiac muscle for detail examination. Deep, adjacent and parallel incisions were made above the point of elbow in the shoulder muscle.

Examination of the kidney, liver, and the lung was also conducted accordingly.

All positive samples were transported to the parasitology laboratory of Bahir Dar regional laboratory for confirmation of cyst viability. The cysts were incubated at 37°C for 1 to 2 h using 40% ox bile solution diluted in normal saline.

After this, the scolex was examined under microscope by pressing between two glass slides. The cysts were regarded as viable if the scolex envaginates during the incubation period at the same time the scolex was checked whether it is *T. saginata* metacestode or others based on the size of cysticercus and absence of hook on the rostellum of the envaginated cyst (Gracey et al., 1999).

Questionnaire survey

To determine associated risk factors of taeniosis, 69 volunteer respondents were selected using simple random sampling methods based on willingness to participate on Questionnaire survey. Questionnaire survey respondents identified for this study were questioned on their habit of raw meat consumption, frequency of consumption, experience of taeniosis infection and finding of proglottids in their faeces, underwear, Religion (Christian and Muslim), educational status, age (less than 15 years, 16-30 years old and greater than 30 years old), sex, marital status, knowledge of *T. saginata* and toilet availability of respondents were registered as possible risk factors.

Data management and analysis

The data collected from the abattoir and questionnaire survey were stored into Microsoft excel. Statistical analysis was done using SPSS version 20. Chi-square (X²) test was used to determine the variation in infection, prevalence between body conditions, ages and origin. Statistical significance was set at P<0.05 to determine whether there are significant differences between the parameters measured between the groups.

The questionnaire data were also summarized and analyzed to the risk factors for human taeniosis using Chi Square(X²) SPSS, Version 20.

RESULTS

Active abattoirs survey

From the total of 480 inspected animals in Bahir Dar

municipal abattoir, 20 animals had different number of *C. bovis* with prevalence of 4.2% (20/480). In routine meat inspection, *C. bovis* was found in different organs with higher number of cyst in the tongue (12, 2.5%), shoulder (10, 2.08%), masseter muscle (7, 1.46%), heart (4, 0.8%) and liver (1, 0.21%) (Table 1).

Out of 119, *C. bovis* (73, 61.3%) were found to be alive while the rest (46, 38.7%) were degenerative cysts. The viable cyst detected in shoulder muscle (31, 72.1%), masseter muscle (16, 59.26%), heart (5, 55.6%), tongue (20, 51.3%) and liver (1,100%) (Table 2). Out of 118 (<5 years old), 237(6-10 years old) and 125 (>10years old) cattle 4 (3.4%), 10 (4.2%) and 6(4.8%) were positive for cysts respectively. There was no statistical difference for the three age groups and body condition score with the occurrence of *C. bovis* (p>0.05). The distribution of infection in cattle according to location was highest in cattle from Debretabor (15, 7.2%), followed by Adet (3, 3.1%), Este (2,1.6%) and Bahir Dar 0%. There was statistically significant difference in infected animal from different locations with the occurrence with *C. bovis* (P<0.05) (Table 3).

Questionnaire survey

From the total of 69 respondents interviewed in this study, 30.4% (21/69) had contracted *T. saginata* infection. Associated risk factors, age groups, frequency of raw meat consumption, sex, presence or absence of the latrine and religion showed statistically difference (p<0.05) in the prevalence of human taeniosis in this study. However, marital status, educational status, occupation and knowledge about the disease was not statistically significance difference (p>0.05) (Table 4).

DISCUSSION

Abattoirs survey of bovine Cysticercosis

The prevalence of bovine cysticercosis obtained in this study was 4.2% which is comparable to the report of Dawit (2004) (4.9%) at Gondor, Megersa et al. (2009) (4.4%) in Jimma, Belay and Mekelle, (2014) who reported (5.2%) in shire and Ibrahim and Zerihun, (2011) (3.6%) in Addis Ababa. However, slightly higher than the finding of Meron (2012) (2.5%) in Jimma, Adem and Alemneh (2016) (2.0%) at Gondar, Addisu and Wondimu (2015) (2.6%) in Batu, Bedu et al. (2011) (3%) in Zeway and Teka (1997) (2.2%) in Central Ethiopia. The present study was by far less than the report of other authors such as Getachew (1990) (13.8%) at Debre-Zeit, Regassa et al., (2009)(13.3%) at Wolaita, Birhanu and Abda, (2014) (19.7%) at Adama. The lower prevalence of cysticercosis in the study area could be due to the differences in the agro-climatic conditions, variation in personal and environmental sanitation, proper usage of latrine, culture

Table 1. Organs based prevalence of *C. bovis*.

Organ inspected	Number of animals inspected	Number of positive animals	Prevalence (%)
Tongue	480	12	2.5
Shoulder	480	10	2.08
Masseter	480	7	1.46
Heart	480	4	0.8
Liver	480	1	0.21

Table 2. The proportion of viable cysts is calculated from the total number of viable cysts as denominator.

Organ inspected	Number of cysts per organ examined	Number of viable Cysts per organ	Proportion of viable Cysts in each organ (%)
Tongue	39	20	51.3
Masseter	27	16	59.26
Liver	1	1	100
Heart	9	5	55.6
Shoulder	43	31	72.1
Total	119	73	61.3

Table 3. The associated risk factors of bovine cysticercosis.

Risk factor	Number of tested animal	Number of positive animals	Prevalence (%)	X ²	P-value	
Age	<5	118	4	3.4	0.306	0.858
	6-10	237	10	4.2		
	>10	125	6	4.8		
Body condition	2	55	1	1.8	0.858	0.651
	3	246	11	4.5		
	4	179	8	4.5		
Location	Debretabor	207	15	7.2	9.459	0.024
	Adet	98	3	3.1		
	Bahirdar	51	0	0		
	Este	124	2	1.6		

and feeding habit of raw meat. Regarding the anatomical prevalence of cysts, tongue 12 (2.5%), shoulder 10 (2.08%), masseter muscle 7 (1.46), heart 4 (0.8%) and liver 1 (0.21%) (Table 1). The tongue and shoulder muscle have high blood circulation and high oxygen circulation are available and due to this they are frequently affected by cysts. The tongue was the most frequently affected organ and this is in line with the finding of Bedu et al. (2011) at Zeway. Shoulder, masseter muscle and heart were also predilection sites Zerihun (2011) in Addis Ababa.

The viability test showed that 73 (61.3%) of the 119 cysts were alive (Table 2). Shoulder muscle had the

highest proportion of viable cyst (31, 72.1%) followed by masseter (16, 59.26%), heart (5, 55.6%) and tongue (20, 51.3%). Only one viable cyst was detected in liver. The shoulder muscles affected 72.1%; greater than the reports of Bekele et al. (2009) (46.3%) and Regassa et al (2009) (32%). The proportion of viable cyst in tongue was 51.3% which was comparable to the work of Hussein et al. (2011) (53.1%).

Questionnaire survey

The prevalence of human taeniasis differs from country to

Table 4. Associated risk factors of human taeniasis.

Variable		Number interviewed	Number positive	Prevalence (%)	χ^2	P-value
Age	< 15	7	0	0	11.534	0.003
	16-30	30	5	16.7		
	> 30	32	16	50		
Sex	Male	40	18	45	9.536	0.002
	Female	29	3	10.3		
Religion	Christian	51	19	37.25	4.295	0.038
	Muslim	18	2	11.1		
Occupation	Government-employed	21	5	23.8	2.305	0.316
	Private worker	30	12	40		
	unemployed	18	4	22.2		
Education	Elementary	13	2	15.4	4.564	0.102
	High school	20	4	20		
	College	36	15	41.7		
Marital status	Married	28	10	35.7	2.127	0.345
	Single	37	11	29.7		
	divorced	4	0	0		
Habit of raw Meat	High	22	14	63.6	18.555	0.000
	Medium	28	6	21.4		
	Less	8	1	12.5		
	Non user	11	0	0		
Latrine	Have	61	16	26.2	4.395	0.036
	Do not have	8	5	62.5		
Knowledge	Have	38	15	39.5	3.264	0.071
	Do not have	31	6	19.4		

country, and it can vary within the same country. This might be the habit of raw meat consumption, knowledge about the mode of transmission of the disease and variation in personal and environmental sanitation. In the present study, the questionnaire survey revealed that the respondents disclosed the finding of proglottids in the faeces, underwear, in laboratory diagnosis facilities at health institution which indicates the presence of taeniasis. Accordingly, 30.4% (21/69) of surveyed individuals were previously affected with the disease. This result was lower than the work of Taresa et al. (2011) (64.44%) in Jimma, Megersa et al. (2009) (56.6%) in Jimma, Dawit (2004) (69.2%) in Gondar. The lower prevalence of *T. saginata* in this study might be the fact that some people are not willing to tell that they had contracted taeniasis, poor environmental hygiene and

knowledge of the societies about taeniasis, way of transmission and variation in composition of the respondents, and the habit or culture of raw meat consumption may be low.

There was statistical difference of age groups, sex, religion, habit of raw meat feeding and toilet availability with the occurrence of taeniasis ($p < 0.05$). Older age groups (>30) have higher prevalence associated with long-term exposure and the habit of preferring raw meat consumption and also, older individuals can financially afford consuming raw meat mainly at butcher houses. The present study showed that taeniasis occurrence was higher in male. This might be due to the cultural and social factors in which the males are usually involved in slaughter houses and butchery as well as having access to the hotels meal. This result is in agreement with

different reports in various parts of our country (Hailu, 2005) in eastern Shoa. The present study showed that there was higher prevalence of human taeniasis among individuals who often consume raw meat than those with occasional consumption. This was comparable with the report of Abunna et al. (2008). However, there was no statistical difference among marital status, education level, occupation and knowledge of taeniasis with occurrence of taeniasis ($p>0.05$).

During the studying period, there was total and partial condemned masseter muscle, shoulder muscle, tongue, heart and liver. Repetition of this reflected high economic loss annually. Besides the health or pathological impact of the problem on the exposed population, the cost of treatment to expel the parasite from the body is also high.

CONCLUSION AND RECOMMENDATIONS

Taeniasis and bovine cysticercosis are important zoonotic parasitic diseases in the study areas with prevalence of 30.4 and 4.2% respectively. Poor meat inspection procedures were applicable in Bahir Dar municipal abattoir. Consumption of raw and undercooked meat is the most important source of infection. Backyard slaughtering were also practiced which could be considered as the contributing factor for taeniasis. Religion, raw meat consumption, presence or absence of the latrine, age and sex were found to influence taeniasis. *T. saginata* is a medically and economically important parasite in humans. Infection with the *Cysticercus* larval stage in cattle causes economic loss in the beef industry. Based on the above conclusion, recommendations include backyard cattle slaughter should be discouraged, routine meat inspection procedure should be applied, the public should be made aware to use latrines, not to contaminate the environment with proglottids or *Taenia* eggs by defecating on pastures where cattle graze and further studies on the prevalence of taeniasis and cysticercosis should be encouraged in other areas.

CONFLICTS OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENT

The authors are greatly grateful to the staff of Bahir Dar Municipal Abattoir, Bahir Dar regional parasitology laboratory and College of Veterinary Medicine, Mekelle University for their kind reception, preparation of equipment, materials, logistic and financial support for the thesis work and the use of their laboratory.

REFERENCES

- Abunna F, Tilahun G, Megersa B, Regassa A, Kumsa B (2008). Bovine cysticercosis in cattle slaughtered at Hawassa Municipal Abattoir, Ethiopia. Prevalence, cyst viability, distribution and its public health implication. *Zoonosis Public Health* 55:82-88.
- Addisu D, Wondimu D (2015). Prevalence of *Taenia saginata* / cysticercosis and community knowledge about zoonotic cestodes in and Around Batu, Ethiop. *Vet. Sci. Technol.* 6:273.
- Adem E, Alemneh T (2016). The occurrence of *Cysticercus bovis* at Gondar ELFORA Abattoir, Northwest of Ethiopia. *J. Cell Anim. Biol.* 10(3):16-21.
- Bureau of Agriculture and Development (BARD) (2009). Bahir dar zuriya woreda agricultural and rural development office, Bahir dar, Ethiopia. 106:97-103.
- Bedu H, Tafess K, Shelima B, Weldeyohannes D, Amare B (2011). Bovine cysticercosis in cattle slaughtered at zeway municipal abattoir, prevalence and its public health importance. *J. Vet. Sci. Technol.* 2(108):2157-7579
- Bedu H, Tafess K, Shelima B, Woldeyohannes D, Amare B, Kassu A (2011). Bovine cysticercosis in cattle slaughtered at Zeway municipal abattoir: Prevalence and its public health importance. *J. Vet. Sci. Technol.* 2(108):2157-7579.
- Belay S, Mekelle BA (2014). Prevalence of *Cysticercus bovis* in Cattle at Municipal Abattoir of Shire. *Vet. Sci. Technol.* 5(4):1.
- Birhanu T, Abda S (2014). Prevalence, economic impact and public perception of hydatid cyst and *Cysticercus bovis* on cattle slaughtered at Adama Municipal Abattoir, South Eastern Ethiopia. *American-Eurasian J. Sci. Res.* 9(4):87-97.
- Central Statistical Agency (CSA) (2007). Population and Housing Census Report, National. Available at: https://unstats.un.org/unsd/statcom/statcom_08_events/special%20events/population_census/docs/presentation%20at%20Stat%20Com-UN%20Samia1.pdf
- Chhabra MB, Singla LD (2009) Food-borne parasitic zoonoses in India: Review of recent reports of human infections. *J. Vet. Parasitol.* 23(2):103-110.
- Chhabra MB, Singla LD (2014) Leishmaniasis. In: *Zoonosis: Parasitic and Mycotic Diseases*, Garg SR (Ed), Daya Publishing House, New Delhi. pp. 134-147.
- Dawit S (2004). Epidemiology of *T. saginata* and cysticercosis in North Gondar Zone, North west Ethiopia. DVM Thesis, Faculty of Veterinary Medicine, Addis Ababa University, DebreZeit, Ethiopia. 4(5):47-53.
- Getachew B (1990). Prevalence and significance of *Cysticercus bovis* among cattle slaughtered at Debre zeit abattoir. Unpublished DVM thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia.
- Gracey F, Collin S, Hilly J (1999). Meat hygiene (10th ed.) W.B. Saunders Company. pp. 669-678. Available at: <https://www.scribd.com/doc/48046190/meat-hygiene-gracey-10-edition>
- Hailu D (2005). Prevalence and risk factor for *T. saginata* cysticercosis in three selected areas of eastern Shoa. MSc Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Debre-Zeit, Ethiopia.
- Ibrahim N, Zerihun F (2011). Prevalence of *Tania saginata* cysticercosis in cattle slaughtered in Addis Ababa Municipal Abattoir, Ethiopia. *Glob. Vet.* 8(5):467-471.
- Megersa B, Tesfaye E, Regassa A, Abebe R, Abunna F (2009). Bovine cysticercosis in cattle slaughtered at Jimma Municipal Abattoir, South western Ethiopia. Prevalence, cyst viability and its socio-economic importance. *Vet. World* 3(6):257-262.
- Megersa B, Tesfaye E, Regassa A, Abebe R, Abunna F. (2009). Bovine cysticercosis in cattle slaughtered at Jimma Municipal Abattoir, South western Ethiopia: Prevalence, cyst viability and Its Socio-economic importance. *Vet. World Res.* 3(6):257-262.
- Meron T (2012). Risk of human taeniasis and prevalence of bovine cysticercosis in Jimma town, Southwestern Oromia. MSc Thesis, Faculty of Veterinary Medicine, Addis Ababa University, DebreZeit, Ethiopia. Available at: <http://etd.aau.edu.et/bitstream/123456789/5682/1/3.%20meron%20sc%20final%20thesis%202012.pdf>

- Meslin FX, Stohr K, Heymann D (2000). Public health implications of emerging zoonoses. *Revue Scientifique et Technique-Office International des Epizooties* 19(1):310-313
- Ministry of Agriculture (1972). Meat Inspection Regulations. Legal notice No. 428 Negarite Gazeta. Addis Ababa, Ethiopia 14 (6):67-71.
- Minozzo J, Gusso R, Castro D, Lago O, Soccol T (2002). Experimental bovine infection with *Taenia saginata* eggs: recovery rates and cysticerci location. *Braz. Arch. Biol. Technol.* 45(4):451-455.
- Mulugeta A (1997). Bovine cysticercosis: prevalence, economic and public health importance at Bahir Dar Municipality Abattoir. DVM Thesis. Faculty of Veterinary Medicine, Addis Ababa University, Ethiopia.
- OIE (World Organisation for Animal Health), WHO (World Health Organization) and FAO (Food and Agriculture Organization), (WHO/FAO, 2005). WHO/FAO/OIE Guidelines for the surveillance, prevention and control of taeniosis/cysticercosis. OIE, 12, rue de Prony, 75017 Paris, France.
- Regassa A, Abunna F, Mulugeta A, Megersa B (2009). Major Metacestodes in cattle slaughtered at Wolaita Soddoo Municipal abattoir, Southern Ethiopia. Prevalence, cyst viability, organ distribution and socioeconomic implications. *Tropical Animal Health Production*. Pp.1495–1502. Available at: <https://www.ncbi.nlm.nih.gov/pubmed/19353302>
- Singla LD (2012) Toxoplasmosis an opportunistic zoonosis: Disease manifestations and managemental issues. In: *Integrated Research Approaches in Veterinary Parasitology*, Shanker D, Tiwari J, Jaiswal AK and Sudan V (Eds), Bytes & Bytes Printers, Bareilly. pp. 198-209.
- Sumbria D, Singla LD, Gupta SK (2016). Arthropod invaders pedestal threats to public vigor: An overview. *Asian J. Anim. Vet. Adv.* 11:213-225.
- Tadesse A, Tolossa YH, Ayana D, Terefe G (2012). Bovine cysticercosis and human taeniosis in South-west Shoa zone of Oromia Region, Ethiopia. *Ethiop. Vet. J.* 17(2):121-133
- Taresa G, Melaku A, Bogale B, Chanie M (2011). Cyst viability, body site distribution and bovine cysticercosis at Jimma, South West Ethiopia. *Glob. Vet.* 7(2):164-168.
- Tembo A (2001). Epidemiology of *Taenia saginata* taeniasis and cysticercosis in three selected agro-climatic zones in central Ethiopia. M.Sc thesis, Faculty of Veterinary Medicine, Addis Ababa University.
- Thrusfield M (2007). *Veterinary Epidemiology*. (3rded.). London, Blackwell Science. P 642. Available at: <http://eu.wiley.com/WileyCDA/WileyTitle/productCd-1405156279.html>
- Torgerson R, Macpherson N (2011). The socioeconomic burden of parasitic zoonoses, *Glob. Trend Vet. Parasitol.* 182(1):79-95.
- Urquhart GM, Armour J, Duncan JL, Dunn AM, Jennings FW (1996). *Veterinary Parasitology*, 2nd ed., Blackwell science Ltd. London, UK.
- World Health Organization (WHO) (2004). Developing and Maintaining Food Safety Control Systems for Africa Current Status and Prospects for Change, Second FAO/WHO *Global Forum of Food Safety Regulators*, Bangkok, Thailand. pp.12-14. Available at: <http://www.fao.org/docrep/meeting/008/ae144e/ae144e00.htm>