

**BOVINE CYSTICERCOSIS AND HUMAN TAENIOSIS: PREVALENCE, PUBLIC
HEALTH AND ECONOMIC IMPORTANCE AND COMMUNITY AWARENESS IN AND
AROUND HALABA KULITO TOWN, CENTRAL ETHIOPIA REGIONAL STATE**



MASTER OF SCIENCE THESIS

BY

OMER IDRIS HABIB

HAWASSA UNIVERSITY

FACULTY OF VETERINARY MEDICINE

NOVEMBER, 2023

HAWASSA, ETHIOPIA

BOVINE CYSTICERCOSIS AND HUMAN TAENIOSIS: PREVALENCE, PUBLIC HEALTH AND ECONOMIC IMPORTANCE AND COMMUNITY AWARENESS IN AND AROUND HALABA KULITO TOWN, CENTRAL ETHIOPIA REGIONAL STATE

OMER IDRIS HABIB

**A Thesis Submitted to the Faculty of Veterinary Medicine, School of Graduate Studies
Hawassa University in Partial Fulfillment of the Requirements for the Degree of Master of
Science in Veterinary Public Health**

Academic advisor: Professor Jemere Bekele Harito (DVM, MSc, PhD)

November, 2023

Hawassa, Ethiopia

STATEMENT OF THE AUTHOR

First, I declare that this thesis is my original work and that all sources of materials used for this thesis have been duly acknowledged. It has been submitted in partial fulfillment of the requirements for Master of Science in Veterinary Public Health at Hawassa University, Faculty of Veterinary Medicine. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate. Brief quotation from this thesis are allowable without special permission provided that accurate acknowledgement of source is made.

Name: Omer Idris Habib

Signature: _____

Date of Submission: _____

Hawassa University, Faculty of Veterinary Medicine

ADVISOR APPROVAL SHEET

This is to certify that the thesis entitled as **“BOVINE CYSTICERCOSIS AND HUMAN TAENIOSIS: PREVALENCE, PUBLIC HEALTH AND ECONOMIC IMPORTANCE AND COMMUNITY AWARENESS IN AND AROUND HALABA KULITO TOWN, CENTRAL ETHIOPIA REGIONAL STATE”** submitted in partial fulfillment of Master of Veterinary Public Health, the Graduate Program of Faculty of Veterinary Medicine, and has been carried out by Omer Idris Habib (Id.No GPuePuR 0007/14) under my supervision. Therefore I recommended that the student has fulfilled the requirements and hence he can submit the thesis to the department.

Academic advisor: Professor Jemere Bekele Harito (DVM, MSc, PhD)

Signature: _____

Date: _____

SCHOOL OF GRADUATE STUDIES

HAWASSA UNIVERSITY

EXAMINERS APPROVAL SHEET (Submission Sheet-2)

We, the under signed member of the board of examiners of the final open defense by Omer Idris Habib have read and evaluated his thesis entitled “**BOVINE CYSTICERCOSIS AND HUMAN TAENIOSIS: PREVALENCE, PUBLIC HEALTH AND ECONOMIC IMPORTANCE AND COMMUNITY AWARENESS IN AND AROUND HALABA KULITO TOWN, CENTRAL ETHIOPIA REGIONAL STATE**” and examined the candidate. This is therefore, to certify that the thesis has been accepted in partial fulfillment of the requirements of Masters of Veterinary Public Health.

Name of Major Advisor: _____ Signature _____ Date: _____

Name of Internal Examiner 1: _____ Signature _____ Date: _____

Name of Internal Examiner 2: _____ Signature _____ Date: _____

Name of External Examiner 1: _____ Signature _____ Date: _____

SGS Approval _____ Signature _____ Date: _____

Final approval and acceptance of the thesis is contingent upon the submission of the final copy of the thesis to the School of Graduated Studies (SGS) through the Department/School Graduate Committee (DGC/SGC) of the candidates department.

Stamp of SGS _____ **Date** _____ **Remark** _____

BIOGRAPHICAL SKETCH

The author, Omer Idris Habib was born in October 1991 G.C in Shashemene town. He attended his primary education from Grade 1-6 at Shashemene Elementary Schools (West Arsi Zone) in a period from 1998/99-2003/2004 G.C. and secondary from Grade 7-12 in a period from 2004/005-2009/2010 at Halaba kulito Secondary and Preparatory Schools, Central Ethiopia Regional State. Then, he took the Ethiopian School Leaving Certificate Examination (ESLCE) in 2010 G.C, and joined Jigjiga University, Faculty of Veterinary Medicine in 2011 G.C, where he had attended veterinary education and been awarded with the Degree of Doctor of Veterinary Medicine (DVM) in 2016. Following graduation, he was employed at Halaba Zone, Central Ethiopia Regional State (Atoti Ullo Wereda) Livestock and Fishery Office as Animal Health Coordinator and served until September, 2022 and then joined the Faculty of Veterinary Medicine School of Postgraduate Studies, Hawassa University, to pursue his study for the degree of Master of Science in Veterinary Public Health.

Contact phone = +251926169385

Email address=idrisomer9271@gmail.com

TABLE OF CONTENTS

CONTENTS	PAGE
TABLE OF CONTENTS	i
LIST OF TABLES	iv
LIST OF FIGURES	v
ANNEXES	vi
ACKNOWLEDGEMENT	vii
LIST OF ABBREVIATIONS	viii
ABSTRACT.....	IX
1. INTRODUCTION.....	1
1.1. Background of the Study	1
1.2. Statement of Problem.....	3
1.3. Objectives of the Study	3
<i>1.3.1. General Objective</i>	<i>3</i>
<i>1.3.2. Specific Objectives.....</i>	<i>4</i>
2. LITERATURE REVIEW	5
2.1. Historical Background.....	5
2.2. Description of the Parasite	6
2.2.1. Taxonomy.....	6
2.3. Morphology.....	6
2.3.1. Adult Parasite	6
2.3.2. Egg Stage.....	7
2.3.3. Metacestodes (Cysticerci).....	8

2.4. Epidemiology	9
2.5. Status of Bovine Cysticercosis in Ethiopia.....	11
2.6. Host Range	14
2.7. Life Cycle	14
2.8. Pathogenesis.....	15
2.9. Clinical signs	16
2.9.1. <i>In Human</i>	16
2.9.2. <i>In Animals</i>	17
2.10. Diagnosis	17
2.11. Treatment.....	18
2.12. Control and Prevention	19
2.13. Public Health Importance	21
2.14. Economic Importance	21
3. MATERIALS AND METHODS	23
3.1. Description of the Study Area.....	23
3.2. Study Population	24
3.3. Study Design	24
3.4. Sample Size Determination	25
3.5. Study Methodology	25
3.5.1. <i>Active Abattoir Survey</i>	25
3.5.2. <i>Cyst Viability Test</i>	26
3.5.3 <i>Questionnaire-Based Investigation</i>	27
3.5.4 <i>Retrospective Data Survey From Health Institutions</i>	28
3.5.5 <i>Inventory of Pharmaceutical Shops</i>	28
3.5.6. <i>Estimation of Direct Financial Loss</i>	28

3.6. Data Management and Analysis	29
4. RESULTS	30
4.1. Prevalence and Organ Distribution of Bovine Cysticercosis	30
4.2. Anatomical Distribution of Cysts.....	31
4.3. Cyst Distribution and Characterization.....	32
4.4. Estimation of Financial Loss Due to Organ Condemnation	33
4.5. Inventory of Pharmaceutical Shops in Halaba Kulito Town	33
4.6. Questionnaire Survey Results	35
4.7. Retrospective Data Survey From Health Institutions.....	38
5. DISCUSSION	40
6. CONCLUSION AND RECOMMENDATIONS.....	45
7. RERERENCES	46
8. ANNEXES	59

LIST OF TABLES

Table 1: Few extracted data for distribution of bovine Cysticercosis studied in different Part of Ethiopia From (1990-2023).....	13
Table 2: Prevalence of <i>Cysticercus bovis</i> in Relation with ge, sex, breed, body condition scores and origin of the animals.....	31
Table 3: Prevalence, frequency and distribution of <i>Cysticercus bovis</i> in different organs and tissues of affected animals	32
Table 4: Proportion of viable, non-viable and calcified cysts inspected in different organs	33
Table 5: Inventory of pharmacies supplying taenicial drugs in the study areas (Halaba) showing annual and total estimated cost from January 2019 to June 2023.....	34
Table 6: Community awareness/knowledge about association of studied factors with risk of <i>Taenia saginata</i> contraction in and around Halaba kulito town.....	36
Table 7: Retrospective clinical case reported of human patients infected with <i>Taenia saginata</i> by age, sex and years in Halaba Kulito General Hospital and Health Center from January 2019 to August 2023.	39

LIST OF FIGURES

- Figure 1:** Life cycle of *Taenia saginata*; source: (Symth, 1994) **15**
- Figure 2:** Map of Ethiopia depicting the location of the study area(Halaba zone) **23**

ANNEXES

Annex 1: Questionnaire survey format sheet.....	71
Annex 2: Abattoir report data collection format sheet.....	73
Annex 3: Pharmaceutical retrospective data collection format sheet	73
Annex 4: Retrospective Health institutions data collection format sheet.....	78
Annex 5: Description of body condition scores	75
Annex 6: Equipment and chemical (reagent) used in the laboratory for cyst viability test.....	76
Annex 7: A few Pictures taken during sample collection in the abattoir and Laboratory	77

ACKNOWLEDGEMENTS

First of all, I would like to express my thankfulness to my academic advisor Professor Jemere Bekele for providing the guidance, correction valuable comments and suggestions, to make this thesis have its shape, and secondly I would like to extend my deepest gratitude to Dr Mohammed Nureye a former chief administrator of Halaba zone, currently in Vice-president title, head of transport and road development in Central Ethiopia Regional State for financial support during my whole academic journey. I deeply acknowledge Dr. Dubale Beyene and Dr. Yohannes H/Michael for their encouragement, motivation, guidance, correction, and technical advice during my research write up.

It is a great pleasure to acknowledge Halaba General Hospital and Health Center management members for their willingness to let me carry out my study at their institution. I would also like to extend my thankfulness to Wolaita Sodo Regional Veterinary Laboratory Research Institute management members and lab technicians particularly Dr Ephrem Takele and Mr Beyene Dacho for their cooperation in allowing me to utilize their laboratory materials and equipment during sample collection and conducting viability tests. I would like to extend my gratefulness to the management and meat inspection personnel of the Halaba Kulito municipal abattoir for allowing me to conduct my research in the abattoir. Finally I would like to express my gratefulness to my close friends who have shared all sorts of educational life with me during the period of our stay in this postgraduate study program.

LIST OF ABBREVIATIONS

CSA	Central Statistical Agency
EARO	Ethiopian Agricultural Research Organization
FAO	Food and Agricultural Organization
HZARDO	Halaba Zone Agricultural Rural Development Office
ILCA	International Livestock Research Centre for Africa
MOA	Ministry of Agriculture
OIE	Office of International des Epizooties
USA	United State of America
WHO	World Health Organization

ABSTRACT

bovine cysticercosis is the infection of the cattle intermediate host with the metacestode (larval stage) residing in the muscle while taeniosis is the infection of the human ultimate host with the adult tapeworm which develops in the intestinal lumen. This study aimed to estimate prevalence, public health and economic importance and community awareness in and around halaba kulito town, Central Ethiopia Regional State. Hence, a cross-sectional study was conducted from January to June 2023 on cattle slaughtered at Halaba Kulito municipal abattoir. Retrospective surveys of patients' demographic data and the results of five years of stool examination were also collected from the diagnostic laboratory record book at Halaba Kulito General Hospital and Health Center. Questionnaire surveys were also used for assessing community awareness of knowledge, attitude, and practice, exposure risk factors, and treatment trends. A retrospective five-year inventory of pharmaceutical drug shops was also assessed. Out of 439 cattle examined, 21(4.8%) were found to be infected with various numbers of *Cysticercus bovis* in different organs. The prevalence of *Cysticercus bovis* was significantly associated with age categories ($\chi^2=7.12$ $p<0.05$) while other factors namely (origin, sex, breed and body conditions) did not show an association as predictors. Out of 21 infected cattle, the highest proportion of the *Cysticercus bovis* cysts were observed in the tongue 7(33.3%), followed by heart 5(23.8%), masseter muscles 3(14.3%), liver 3(14.3%), shoulder 2(9.5%) and lung 1(4.8%). A retrospective data of 40,993 stool examined patients in the five years, 112(0.27%) were found positive for *Taenia saginata* eggs. Moreover, out of 100 voluntarily interviewed respondents in and surrounding Halaba Kulito town, 64 (64%) had been infected by tapeworm. Data on drug utilization obtained from pharmaceutical shops revealed a total dose of 379,707 taenicial drugs with a total cost of 2,823,766.5 ETB or (48,685.5 USD) was estimated on average within five years for the treatment of taeniosis in the study area. The results of the present study show that cysticercosis/taeniosis are important both in economic and public health aspects which need great attention. Therefore integrated community-based control and prevention strategies including creating awareness for the society to use latrine, avoid consumption of raw meat, and provide strict meat inspection services are highly recommended.

Keywords: *Abattoir, Cysticercus bovis, Halaba, Public health, Retrospective survey, Taenia saginata.*

1. INTRODUCTION

1.1. Background of the Study

The livelihoods of an estimated 80% of the rural poor people in Ethiopia are currently supported and sustained by one of the largest livestock inventories in all of Africa. Animal rearing is a crucial component of agricultural production, with an estimated 70 million cattle, 42.9 million sheep, and 52.5 million goats in existence (CSA, 2022). In Sub-Saharan Africa, animal disease is one of the major obstacles to the production of cattle. One of the many common livestock diseases is parasitism, which is common in Ethiopia and poses a significant barrier to tropical development (Ento, 2005). Bovine cysticercosis is defined as the infection of the cattle intermediate host with the metacestode or larval stage (*cysticercus*) residing in the muscle while taeniosis is the infection of the human ultimate host with the adult tapeworm which develops in the intestinal lumen (Minozzo *et al.*, 2002; Dorny *et al.*, 2009).

Bovine cysticercosis is a disease that continues to be a major public health problem in developing and some industrialized countries. Among the most common livestock diseases; zoonotic infections represent a significant barrier to the development of livestock productivity in Ethiopia (Utulas *et al.*, 2007). *Taenia saginata*, popularly known as the beef tapeworm, is a zoonotic cestode parasite that can infect beef and spread to humans when it is consumed raw or undercooked meat. Infected animals frequently show no clinical symptoms. However, a serious infection with a viable cyst may result in myocarditis to heart failure in cattle (Cabaret *et al.*, 2002), and the cyst is also responsible for significant economic losses due to the loss of carcass by a cyst, which can reach 30% of the animal's value, and the cost of freezing for the infested carcass (Chomel, 2008).

Cysticercus bovis can be found anywhere in the carcass and viscera, but there seems to be special affinity towards some parts that are described as sites of predilection (masseter, tongue, heart, liver, triceps, intercostal muscles, and the diaphragm). Except for the heart, most of these organs are eaten raw or undercooked, which poses a risk to the general public's health by increasing the risk of *Taenia saginata* infection (Minozzo *et al.*, 2002). A person contracts the disease by consuming infected beef that contains live *Cysticercus bovis*. Then, the person excretes eggs that

cattle ingest (Gracy and Collins, 1992). Any interruption in these linkages, which are essential to the parasite's life cycle, could lead to the parasite's complete eradication (Urquhart *et al.*, 2013). *Taenia saginata* infections can even be seen in modern nations with good cleanliness standards and meat that has normally been cooked completely. It spreads throughout the world as a result of tourists who prefer eating gently grilled meat, labor migration on a large scale, the export of meat that hasn't been consistently inspected with "eye or knife," or the result of importing live animals from endemic regions (Mann, 1984). It is significant to remember that studies have shown that eggs can survive practically all phases of sewage treatment. It is noteworthy that this parasite has not been eradicated, despite the high standards of meat inspection anticipated of abattoirs in highly industrialized nations to detect few beef carcasses (Symth, 1994).

In Africa, insufficient health education and low availability of taenicides are the main barriers for the control and prevention of the disease (Pawlowski, 1996). Variations in the epidemiological patterns of Taeniasis/Cysticercosis throughout Africa are a reflection of the numbers and distribution of human and cattle populations (Harrison, *et al.*, 2001). Prevalence rates of 30% to 80% have been noted in East African countries (Tembo, 2001). The cost of freezing the infected meat, the grade of the infected animals from markets, and treatment costs for the detained carcass all contributed to significant economic losses in Africa due to bovine cysticercosis, which is estimated to be around 30% (Grindle, 2012).

In Ethiopia, *Taenia saginata*/taeniosis and bovine cysticercosis have been linked to human behaviors, including the consumption of raw or undercooked beef, backyard slaughtering (kircha), which involves killing animals in front of a person's home frequently without conducting a proper meat inspection, unhygienic conditions, and conventional animal husbandry practices (Kebede, 2008). The epidemiology of parasites needs to be better understood to properly assess the impact of various parasitic diseases on public health, as well as the type and extent of control measures that should be used depending on the distribution of the disease (Ento, 2005). There hasn't been much research done on the community's knowledge, attitude, and practice regarding the cause of infection, symptoms, treatment, and prevention of taeniosis. Taeniosis was very briefly covered in a few researches focusing on the community's knowledge, attitude, and practice of zoonotic diseases and food safety issues (Tesfaye *et al.*, 2013).

1.2. Statement of Problem

There is paucity of information and documented data on *Taenia saginata/Cysticercus bovis*, its prevalence, public health importance, exposure risk factors, treatment trends, and effect on human and animal health in and around Halaba Kulito towns, Central Ethiopia Regional state. The knowledge, attitude, and practice (KAP) of the community concerning the source of infection, symptoms, treatment, and prevention of taeniosis has not been studied so far. Few studies targeting KAP of zoonotic diseases and food safety issues mentioned taeniosis (Tesfaye *et al.*, 2013), but none of those focused on KAP of the community and meat workers (butcher and slaughterer) to taeniosis and bovine cysticercosis. Understanding the KAP of the community and meat workers on *Taenia saginata* and bovine cysticercosis is a significant element to plan well-informed intervention programs and for community engagement in the delivery process. Therefore, the present study was conducted to investigate the KAP of the community and meat workers towards to human taeniosis and bovine cysticercosis and obtaining epidemiological data on *Taeniosis/bovine cysticercosis* is essential before planning and implementation of control and prevention programs. Information resulting from questionnaire, Hospital and Health Center record book should be taken as useful sources of data for the study of the actual distribution and epidemiological aspect of *Taenia saginata* in Halaba Kulito town and surrounding areas.

1.3. Objectives of the Study

1.3.1. General Objective

- ❖ To investigate the prevalence of bovine cysticercosis and human taeniosis with assessment of their economic and public health impacts in Halaba Kulito town and the surrounding areas. .

1.3.2. Specific Objectives

- To assess the status of bovine cysticercosis and human taeniosis in and around Halaba Kulito town and surrounding areas.
- To look at the potential risk factors of bovine cysticercosis and human taeniosis in the study area.
- To assess community knowledge, attitude, and practices towards *Taenia saginata*/taeniosis and bovine cysticercosis in the study area.
- To characterize cyst in view of its public health implication in the study abattoir

2. LITERATURE REVIEW

2.1. Historical Background

According to researchers, African hominids, who are thought to be our distant ancestors and who hunted antelope and other bovid animals for sustenance or preyed on them, were subjected to tapeworm invasion some 2 million years ago (Duncan, 1984). The domestication of swine and cattle, as well as the emergence of agriculture, occurred much earlier than the domestication of hyenas and large cats, which were used by these worms as definitive hosts and bovids as intermediate hosts. These events took place before the formation of modern humans. Instead of humans acquiring *Taenia* from cattle and pigs, researchers believed that man gave tapeworms to these domestic animals because the association between *Taenia* and hominids was established before the domestication of these food animals. The conclusion was based on an examination of host and parasite evolutionary histories as well as evidence for the rate of molecular evolution between species of *Taenia*. Cattle, swine, and companion carnivores did not become intermediate hosts until roughly 10,000 years ago, when agriculture began to take off (Warren and Kenneth, 1993).

Another hypothesis proposed that the origin of *Taenia* and human assemblages occurred through direct predator-prey associations between early humans and bovids like antelopes on sub-Saharan African savannahs during the Pleistocene or earlier (Hoberg, 2002). This hypothesis was based on phylogenetic, geographic, ecological, and molecular data. *Taenia saginata*, *Taenia asiatica*, and *Taenia solium* are sister species that are distantly related to *Taenia solium*, according to a recent phylogenetic analysis of the three tapeworm species that infect humans (*Taenia saginata* with cattle as intermediate host, *Taenia solium*, and *Taenia asiatica* with pigs as intermediate host) (Hoberg *et al.*, 2000). As a result, *Taenia* in humans is at least the result of two separate host-switching events that occurred in the past (Hoberg, 2006).

2.2. Description of the Parasite

2.2.1. Taxonomy

The genus *Taenia* and family Taeniidae are members of the phylum Platyhelminthes, class Cestoda, order Cyclophyllidea, and family Taeniidae. Several species in the genus *Taenia* parasitize the small intestine of humans and animals. *Taenia asiatica*, *Taenia solium*, and *Taenia saginata* are the three major species that infect people (Eom and Rim, 1993 ; Flisser *et al.*, 2005). Recent studies that examined the genetic diversity of *Taenia saginata* using cytochrome c oxidase subunit 1 (cox 1) gene sequencing, phylogenetic tree, and haplotype network analyses found that global isolates of *Taenia saginata* have undergone genetic intra-species divergence (Sanpool *et al.*, 2017). There are about 45 different species of *Taenia*; however, *Taenia solium*, which lives in the pork, and *Taenia saginata*, which lives in the beef, are the two that infect humans most frequently (Schantz, 2002). Both species are found all over the planet. 50 million of these instances are associated with *Taenia solium*, while about 100 million of these cases are *Taenia saginata*-related (Markell *et al.*, 1999).

2.3. Morphology

2.3.1. Adult Parasite

The beef tapeworm, or *Taenia saginata*, is a big worm that can grow up to 15 meters long (Soulsby, 1982). According to Soulsby (1982), it lives for many years in the human small intestine, where it adheres using its scolex. The *Spp.* goes through three unique life cycle stages: adult, egg, and metacestode larval stage (cysticerci). According to Gracey and Thornton (1981), the head (scolex), neck, and strobilla are the three separate components of the body. The head, or scolex, has attachment organs, a short, segmented neck, and a chain of segments; each segment is referred to as a proglottid and the chain as a strobilla. As they move along the strobilla, the proglottids continuously bud from the neck region and develop into sexually mature individuals. Each proglottid has one or two sets of reproductive organs and is hermaphrodite. Gravid

segments frequently migrate independently from the anus and typically depart the host alone (Blancou *et al.*, 2010). By using its head/scolex, which is composed of four suckers and an unarmed rostellum, the adult affixes itself to the upper jejunum. The scolex is a distinguishing characteristic of *Taenia saginata*, which lacks hooks, from *Taenia solium*, which has a scolex armed with hooks (ranging in number from 22 to 36), and *Taenia asiatica*, which has simple hooklets. The neck (5 to 10 mm), a small, short, and undivided area next to the scolex, is where the complete strobila is created and is where there is the most biokinetic activity occurs (Flisser *et al.*, 2005).

A typical adult *Taenia saginata* strobilus contains 1,000–2,000 proglottids. The oldest proglottids, gravid with eggs and resembling sacs full of eggs, are found towards the tapeworm's posterior end. The proximal proglottids are immature and gradually mature. The eggs that the proglottids discharge in the stool are instantly contagious (Flisser *et al.*, 2005). A full complement of male and female reproductive organs is present in each segment, where eggs grow and mature (Symth, 1994). The vaginal sphincter muscle was present in the adult proglottid/segment (OIE, 2000). According to estimates, each gravid segment can hold up to 100,000 eggs, and an infected person may shed between 24 and 50 million eggs each day (Teka, 1997). Small numbers of tapeworm carriers can spread their ova broadly and infect significant numbers of cattle (Harrison and Sewell, 1991). The intermediate host, the bovine, can be infected once the mature eggs are expelled in the feces (Teka, 1997; Minozzo *et al.*, 2002).

2.3.2. Egg Stage

Taenia eggs are very resistant and are discharged from ruptured segments or passed in the feces. They are sub-spherical to spherical and exceedingly resistant; they last for 6 months in pasture and vegetables, 5 weeks in water, 10 weeks in stool or hay, and 12 weeks in silage sludge before becoming inedible. The outer oval membranous coat, or the real egg shell, which is lost from fecal eggs, is covered by a thick, brown, radially striated embryophore or shell consisting of hooks in taenid eggs, which have a diameter of around 30–45µm (OIE, 2000).

Six rudimentary hooks (hexacanth embryos) are present on the oncosphere, but they disappear as it matures. The embryophore, which is made up of keratin-like protein building blocks, covers the oncosphere and shields the egg from the outside world before being digested by the host's digestive enzymes (Flisser *et al.*, 2005).

2.3.3. Metacestodes (*Cysticerci*)

The intermediate host's striated muscles contain the larval stages, or metacestodes, called *Cysticercus bovis* sometimes known as "beef measles." Following in the intermediate host body the *cysticerci* or larval stages develop over 3–4 months following consumption of the egg and remain viable there for up to 9 months or even the entire host's life (Soulsby, 1982). *Cysticercus bovis* is a little (pea-sized), oval-shaped, semi-translucent cyst with a dense, white fluid interior that contains an invaginated scolex (OIE, 2000). The metacestode resembles the future adult tapeworm morphologically; it has a diameter of 10 mm and a length of 6 mm. When the cyst is cut open, it may still be viable and have a thin fibrinous capsule, or it may have degenerated and developed calcification that is either cream or green in color (OIE, 2000).

The edible sections of the carcass, such as the liver, heart, tongue, lung, and kidney, as well as the masseter muscles, cardiac muscles, triceps muscles, thigh muscles, shoulder muscles, diaphragm, and intercostals muscles, all may harbor metacestodes (Kebede *et al.*, 2009; Megersa *et al.*, 2009). According to Harrison and Sewell (1991), *Cystercus bovis* can endure a temperature range of -5°C to -30°C in the carcass for around 15 days, -10°C for 9 days, and -15°C to -30°C for 6 days. If cysts are discovered in a carcass, they must be frozen at -10°C for 10 days, or if the lesions are severe, the carcass is condemned as a whole (Yoder *et al.*, 1994). With time, the skeletal and cardiac muscles' viable cysticerci start to deteriorate and calcify. The calcified lesions are firmer and more apparent while incising, and the deteriorated cysticerci are firm or have creamy, greenish, or yellowish coloring (Flisser *et al.*, 2005; Ferrer and Gárate, 2014).

2.4. Epidemiology

Cysticercosis is one of the neglected zoonotic diseases, while swine neurocysticercosis is given special attention because it is linked to epilepsy (WHO and FAO, 2016). *Taenia saginata* can be found in areas where cattle are farmed, human waste is improperly disposed of, meat inspection programs are inadequate, and meat is consumed raw (Radostits *et al.*, 2007). Taeniasis is believed to be a major geographic distribution and status issue in developing nations, but it is less well-known as a public health issue (Minozzo *et al.*, 2002). Although *Taenia saginata* is found worldwide, it is more prevalent in Africa, Asia, Latin America, and several Mediterranean nations (Fahmy *et al.*, 2015).

Taenia saginata taeniosis and bovine cysticercosis can occur in both developed and developing nations, primarily where raw or undercooked beef is ingested. Worldwide, there are roughly 60,000,000 cases of taeniosis (Craig and Ito, 2007). The prevalence of bovine cysticercosis varies significantly across nations, from less than 0.01% to more than 20% (Meiry *et al.*, 2013). According to Minozzo *et al.* (2002), its prevalence can be divided into three categories. Taeniasis prevalence is high (over 10%), and infection rates are moderate (0.1–10%) and low (less than 0.1%). East and Central African nations (Ethiopia, Kenya, and Zaire) are among those with highly endemic disease areas. Low prevalence is found in Canada, the USA, Australia, and some Western Pacific nations, while moderate prevalence is found in South East Asia (Thailand, India, Vietnam, and the Philippines), Japan, as well as countries in Western Europe and South America (Harrison and Sewell, 1991).

Even in affluent nations with excellent cleanliness standards and meat that has normally been completely cooked, *Taenia saginata* infections can still occur. In wealthy nations, taeniasis/cysticercosis is spread by travelers who prefer eating lightly grilled meat, by labor migration in large numbers, by the export of meat that hasn't been consistently inspected with "eye or knife," or by bringing in live animals from endemic regions. Less than 1% of people in these regions of the world are affected. Cysticercosis "storms" have, nevertheless, sporadically been documented on specific farms (Mann, 1984). According to OIE (2000), the employment of migrant labor and the usage of human waste on pastures were the causes of the storm. The transmission of eggs to cattle occurs when sewage sludge is used to create cattle feed.

According to Cabaret *et al.* (2002), *Taenia saginata* eggs in effluent that enters streams and rivers can readily be transported by surface water or contaminate pastures through flooding. Cattle of any age in affluent nations are vulnerable to infection because they typically lack acquired immunity (Yoder *et al.*, 1994). The higher prevalence of cysticercosis in underdeveloped nations is linked to inadequate infrastructure, low awareness, and inappropriate sewage disposal. This is relevant to Ethiopia, where the widespread practice of consuming raw meat is an additional risk factor (Tolosa *et al.*, 2009). According to earlier observations, taeniid eggs were dispersed from the deposited feces in an open defecation setting by wind, birds, arthropods, and annelids. The significance of wind for a significant dissemination of taeniid eggs is, however, not well supported by experimental data (Murrell, 2005).

If birds frequently come in contact with excrement, long-distance dissemination by birds may be true (Lawson and Gemmell, 1985). Numerous arthropods, including annelids like earthworms (Lonc, 1980), beetles (Vargas-Calla *et al.*, 2018), blowflies (Lawson and Gemmell, 1985), and cockroaches (Chamavit *et al.*, 2011), have been linked to egg distribution. Blowflies and dung beetles seem to be the most likely choices due to their close biological ties to fecal matter (Murrell, 2005). The adult *Taenia saginata* worm sheds four to six proglottids every day in human carriers, either during feces or through active migration. Each proglottid contains 50,000–80,000 eggs, and a single infected individual can release hundreds of thousands of eggs into the environment each day, suggesting that it can produce a lot of eggs and contaminate the environment (Flisser *et al.*, 2005; Dorny and Praet, 2007).

The existence of a tapeworm carrier is an important factor in the transmission because the enormous numbers of eggs entering the environment instantly infect the intermediate host. Since pastures are contaminated by open defecation, which is more common in the global south, this element of inadequate sanitation services is negative. The feces caused by camping, travel, and festivals close to cattle grazing areas are potential additional sources of pasture contamination. As a result, eggs may also be left behind along rivers, railroad tracks, and roadways, where they may pollute pasture land or water supplies and eventually reach intermediate host animals (Laranjo-González *et al.*, 2016).

Cattle are exposed to eggs when sewage sludge is used to grow cattle feed. *Taenia saginata* eggs in the effluent that enters streams or rivers can readily be transported by surface water or pollute

pastures through flooding (Cabaret *et al.*, 2002). Unlike in open defecation situations, poor sanitation conditions allow the eggs to survive anaerobic and aerobic digestion for several months, which allows them to disperse when placed in sewage systems. Eggs in the influent will travel via primary settling tanks, grit tanks, sedimentation tanks, and aeration tanks and through the effluent to rivers or farmland in sewage systems using these technologies. The processes of sedimentation, putrefaction, and oxidation, which allow the eggs to move through the effluent quite freely, are also hampered by the use of detergents (Kyvsgaard and Murrell, 2005).

A possible dangerous technique that could aid in the transfer of eggs to cattle is the improper application of sewage sludge as fertilizer or sewage effluent for irrigation of pastures or crops (Cabaret *et al.*, 2002; Dorny and Praet, 2007). According to Boone *et al.* (2007), other risk factors included pasture flooding, cattle having unrestricted access to surface water, and being close to waste water effluent. Animals are more susceptible to infection when managed in their natural habitat. Compared to commercial herds, cattle that are outgrazing are more likely to come into touch with human feces increasing their risk of acquiring *Taenia saginata* eggs. Cattle on pasture run a substantially higher chance of coming into touch with *Taenia saginata* eggs (Ashwani and Gebretsadik, 2008).

2.5. Status of Bovine Cysticercosis in Ethiopia

Cattle, which produce the majority of the export revenue from the sale of live animals, account for around 45% of the country's domestic meat consumption (EARO, 2015). According to Minozzo *et al.* (2002), taeniasis/bovine cysticercosis is a severe but underappreciated public health issue in underdeveloped nations. Rural Ethiopian communities are mostly engaged in large cattle-rearing methods. In rural locations, a higher population density, a preference for eating raw meat, a lack of knowledge about the disease, poor hygienic conditions, and inadequate sanitary infrastructure may make it easier for disease to spread from animals to people (Fikire *et al.*, 2012).

Bovine cysticercosis is a disease that affects cattle on a large scale. The high frequency of bovine cysticercosis in Ethiopia may be attributed to bush defecation and backyard slaughtering. *Taenia saginata's* life cycle and possible risk factors for infection in cattle should be explained to farmers (Abusier *et al.*, 2006). Taeniasis in humans and cysticercosis in cattle are frequent in Ethiopia as a result of the culture of eating raw or undercooked beef dishes such as kourt, lebleb, and kitfo as well as the practice of defecating in open fields combined with the tradition of allowing cattle to graze in such fields (Teka, 2007).

Since reporting was solely based on routine meat inspection and the procedure outlined in the Meat Inspection Regulation Notice Number 428/1972 by the Government of Ethiopia is not strictly followed at most of the abattoirs, the prevalence of bovine cysticercosis reported by various researchers may be understated (Kumar and Berhe, 2008). Reports on the prevalence of cysticercosis in Ethiopia fluctuate from area to area with a relatively lower prevalence of 3.1% in Central Ethiopia (Tembo, 2001), 4.9% at Gondor (Dawit, 2004), 2.59% at Wolaita Sodo (Dawit *et al.*, 2012), and 7.5% in Addis Ababa (Nigatu, 2004). Some areas reported higher prevalence like 17.5% in East Shoa (Hailu, 2005), 18.49% in Northwestern Ethiopia (Kebede, 2008), and 26.25% at Awassa (Abunna *et al.*, 2007). The prevalence of bovine cysticercosis has been reported by several people in different agro-climatic zones of Ethiopia with varying prevalence reports (Tembo, 2001).

Table 1: Few extracted data for distribution of bovine cysticercosis studied in different part of Ethiopia from (1990-2023).

No.	Place/Area	Prevalence	Year and Author
1	Nekemta	21.7%	Ahmed, 1990.
2	Central Ethiopia	3.1%	Tembo, 2001
3	Gonder	4.9%	Dawit, 2004
4	Addis Abeba	7.5%	Nigatu, 2004
5	East Shoa	17.5%	Hailu, 2005
6	North west Ethiopia	18.5%	Kebede, 2008
7	Hawassa	26.25%	Abunna <i>et al.</i> , 2008
8	Jimma	2.93%	Tolosa <i>et al.</i> , 2009
9	Wolaita Sodo	11.3%	Alemayehu <i>et al.</i> , 2009
10	Jimma	4.4%	Megersa <i>et al.</i> , 2009
11	Addis Ababa	3.6%	Ibrahim, and Zerihun, 2012
12	Wolaita Sodo	2.59%	Dawit <i>et al.</i> , 2012
13	Kombolcha	6.4%	Tewodros <i>et al.</i> , 2015
14	Halaba Kulito	8.6%	Abdulaziz <i>et al.</i> , 2016
15	Dessie	6.8%	Getachew <i>et al.</i> , 2017
16	Debre Brihan	5.43%	Andualem and Belayneh, 2017
17	Kombolcha	8.97%	Aragaw <i>et al.</i> , 2018
18	Nekemta	2.68 %	Wabi and Girmay, 2019
19	Dessie	9.6%	Netsanet <i>et al.</i> , 2020
20	Jiggiga	3.24%	Samatar, 2021
21	Wolaita Sodo	3.13%	Gizaw and Timotiwwos, 2022
22	Silte	36 %	Solomon, 2023

2.6. Host Range

Humans are the only final hosts of *Taenia saginata*, and cattle are favored intermediate hosts. All age groups of cattle are vulnerable, but younger age groups are more vulnerable. Although *Cysticercus bovis* formation is unusual, parasitism is occasionally seen in other ruminants (sheep, goats, antelopes, gazelles, and buffaloes). Taeniasis cannot be transmitted from man to man. When animals are handled in their natural habitats, it puts them at risk for illness. Comparing communal grazing herds to commercial herds, communal grazing herds are more likely to come into touch with human feces, increasing the chance of *Taenia saginata* eggs being picked up by grazing cattle (Harrison and Sewell, 1991). Calves are typically infected early in life, frequently during the first few days after birth, by infected stockmen whose hands are contaminated with *Taenia* eggs (Maedia *et al.*, 1996).

2.7. Life Cycle

Taenia saginata has an indirect life cycle, with cattle acting as the intermediate host and humans as the ultimate host (Soulsby, 1982; Urquahrt *et al.*, 1996). The parasite is primarily spread in environments with inadequate hygienic standards, insufficient meat inspection management and control procedures, and inferior cattle husbandry techniques. As the required final host, humans contract the disease by eating infected meat raw, undercooked, or improperly frozen. Although there have been cases of large-scale outbreaks caused by sewage-contaminated feed or fodder, the majority of incidences in cattle occur as a result of direct exposure to proglottids shed by humans (Tsfaye *et al.*, 2012).

In most cases, the adult tapeworm in the final human host completes the tapeworm life cycle. Additionally, it generates proglottid segments that are heavily populated with eggs which are shed on defecation. The Oncosphere embryo found in *Taenia* eggs is dispersed into the environment by sewage and consumed by intermediate hosts (cattle) before being able to reproduce. The embryo in cattle transfers from the gut to the striated muscle. They grow into tiny vesicles called cysticerci, which contain a proto-scolex, the head of the future adult tapeworm (Kassai, 1999).

It takes around two months for the adult worm to mature in the intestine after people consume the cyst in raw or undercooked beef (Symth, 1994). Between 600 to 2000 proglottids and an unarmed scolex with four noticeable suckers are present on the adult parasite. Eggs are ejected when gravid proglottids lay down to rest. The presence of the eggs is also a result of promiscuous defecation (Teka, 1997; Soulsby, 1982). The oncosphere is transported by the blood to the striated muscle, where it encysts and develops over roughly 12 weeks before becoming infectious to humans. The eggs penetrate and enter muscle tissue once within the animal body. Fortunately, cattle are not able to spread the illness to one another (Urquhart *et al.*, 2013).

However, they are capable of eating eggs that have been exposed to human waste and sewage that have polluted water and food, or by licking dirty objects. However, eating meat that has been undercooked or contains cysts may have negative effects on people. Cysticercosis cannot be transmitted from humans to humans (Gemmell *et al.*, 1983). Finally, Ingestion of raw or improperly cooked meat with live cysts causes infection in humans (Tewodros and Alemneh 2017).

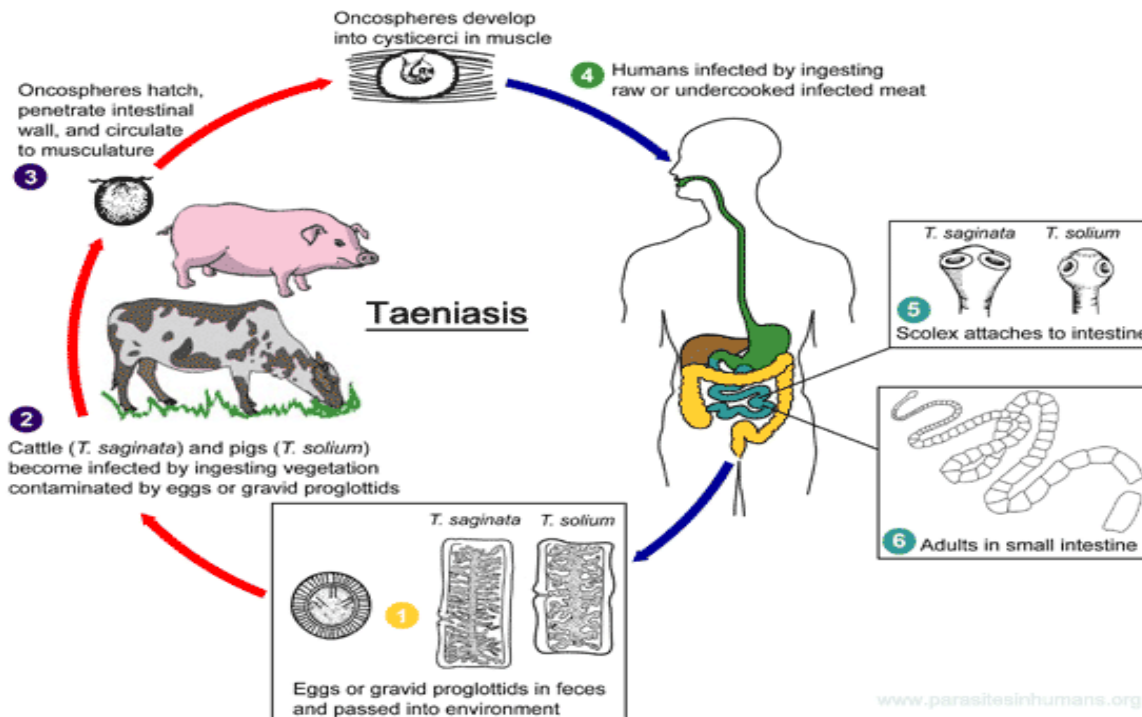


Figure 1: The life cycle of *Taenia saginata* source: (Symth, 1994)

2.8. Pathogenesis

According to Taylor *et al.* (2007), the mature *cysticercus* in the bovine animal is grayish white, small, pea-sized oval, measuring between 0.5cm and 1.0x0.5cm in length, and filled with fluid, usually with the scolex being easily apparent. Human taeniasis presents as a moderate, non-specific gastrointestinal sickness with symptoms of anorexia, nausea, diarrhea, and abdominal pain. Although experiments, where calves, were given massive infections of *Taenia saginata* eggs developed with severe myocarditis and heart failure associated with developing cysticerci in the heart and cause of death between 14 and 16 days, the presence of cysticerci in the muscle of cattle under natural conditions is not associated with clinical signs checked (Utulas *et al.*, 2007). Cattle with severe infections may experience weight loss, muscle stiffness, fever, and gastroenteritis, especially in young animals (FAO, 2004).

2.9. Clinical signs

2.9.1. In Human

Human infections with *Taenia saginata* are typically asymptomatic; however, a little amount of gastrointestinal discomfort and unpleasant feelings brought on by the proglottids actively passing from the anus may be felt. Weight loss, wooziness, stomach discomfort, nausea, diarrhea, constipation, persistent indigestion, and loss of appetite are a few possible signs and symptoms, though. There have been reports of severe digestive issues like intestinal blockage/perforation, peritonitis, ileus, and gallbladder perforation (Hendrickx *et al.*, 2019). The most obvious sign is the spontaneous discharge of one or more proglottids, which frequently exhibit individual muscle activity. These could emerge from the anus and travel onto the perianal skin, across the host's garments, or even on the ground while laying eggs. Humans may experience intestinal blockage, which can be treated surgically. Additionally, the tapeworm can discharge antigens that can trigger an allergic reaction in the host, appendix inflammation, bile duct inflammation, unpleasant surprises in the feces, and obstruction of the colon, stomach ache, and migrating proglottids. Infrequently, it can also cause cholangitis, cholecystitis, and pancreatitis (FAO, 2004).

2.9.2. In Animals

Unless a key organ (like the heart) is substantially infected, which is extremely uncommon, *Cysticercus bovis* is not harmful to cattle and typically causes no clinical indications of illness. Muscle stiffness has been observed in cases of severe infections. Live cattle with *Cysticercus bovis* do not exhibit any symptoms, but a high larval infestation might result in myocarditis or heart failure (Regassa *et al.*, 2009). There is typically no clear clinical picture associated with mild or moderate cysticercosis in cattle. A dose of one million or more *Taenia saginata* eggs may result in death between 14 and 16 days due to degenerative myocarditis. Heavy infections, those induced experimentally by 200,000 to 1,000,000 *Taenia saginata* eggs, may cause fever, weakness, profuse salivation, anorexia, and increased heart and respiratory rate (Oryan *et al.*, 1998).

2.10. Diagnosis

The method utilized for the diagnosis and control of bovine cysticercosis is regular meat inspection. However, this method is ineffective for estimating the true prevalence of bovine cysticercosis due to the low sensitivity of meat inspection (Dorny *et al.*, 2000). Each nation has its laws governing the inspection of corpses, which typically attempt to balance the interests of owners and consumers (Harrison and Sewell, 1991). The only diagnostic technique used in Ethiopia to identify *Cysticercus bovis* is the routine meat inspection. The reported prevalence of this infection in various parts of the country may be understated as a result of this method's sensitivity issues and accuracy. Increasing the incision area and number of predilection spots noticed during inspection operations to successfully improve the quality of meat (Kumar and Tadesse, 2011).

According to Ethiopian Meat Inspection Regulation Notice Number 428/1972, the following are outlined as standard routine carcass inspection procedures by the Ministry of Agriculture: The inspection of the carcass includes visual inspection, palpation of the surfaces, a longitudinal ventral incision of the tongue from the tip to the root, one deep incision into the triceps muscles of both sides of the shoulder, an extensive deep incision into the external and internal muscles of

the masseter parallel to the plane of the jaw, visual inspection, and a longitudinal incision of the myocardium from base to apex (MOA, 2015). Meat inspectors who adhere to established protocols only visually evaluate the intact and cut surfaces of the carcass during the eye-and-knife approach in the slaughterhouse (Yoder *et al.*, 1994). Nevertheless, no matter how skilled the inspector is, it can be challenging to find tiny illnesses. A thorough examination of the entire carcass and offal should be conducted if a *Cysticercus bovis* is discovered in any of these locations or organs. It is important to note the cysts' location, type, and number (Kumar *et al.*, 2011).

The edible sections of the carcass, such as the liver, heart, tongue, lung, and kidney, as well as the masseter muscles, cardiac muscles, triceps muscles, thigh muscles, shoulder muscles, diaphragm, and intercostal muscles, all include metacestodes (Kebede *et al.*, 2009; Megersa *et al.*, 2009). Since the eggs of *Taenia saginata* cannot be separated from those of other *Taenia* species, the proglottid must be identified to make a conclusive diagnosis in cases involving humans (Harrison and Sewell, 1991; Teka, 1997). Patients can detect the active migration of proglottids out of the anus and spontaneous evacuation of proglottids is prevalent in *Taenia saginata* carriers. Patients may report finding proglottids in their stools, undergarments, toilet paper, or bed sheets, which may be used as an additional diagnostic technique (Dorny *et al.*, 2005).

2.11. Treatment

Traditional treatments have been used for a long time to treat taeniosis, including extracts from male fern (*Dryopteris filix-mass*) in Europe and areca nuts in Asia, Kosso flowers (*Hagenia abyssinica*), and pumpkin seeds (*Cucurbita pepo*, *C. maxima*) in Ethiopia. Ethiopia still makes use of a few of the conventional herbal remedies. Nevertheless, Pawlowski *et al.* (2005) found that these conventional treatments were not secure and were insufficient. Nicolosamide and praziquantel (Okello and Thomas, 2017), and albendazole (Steinmann *et al.*, 2011) are the three effective anthelmintic medications for the treatment of taeniosis. The effectiveness of praziquantel against intestinal tapeworms, cysticerci, and some trematodes, such as schistosomes, is 95%. The treatment of human taeniosis involves a single oral dose of 5–10 mg/kg. It works in part by impairing the worm's sucker's performance, raising calcium

permeability, and inducing blisters on the integument. According to reports, albendazole treats 50% of taeniosis patients with a single 400 mg dose, but a triple dose treatment (three 400 mg doses over three days) cures everyone (Steinmann *et al.*, 2011). Both the adult and the larva are killed by praziquantel. Even when encysted and disintegrating after 5 months, the majority of the larvae are destroyed (WHO, 1995). According to Pawlowski *et al.* (2005), albendazole, a broad-spectrum anthelmintic, reduces glucose uptake, depletes glycogen stores, and ultimately kills the worm. The effectiveness of albendazole sulphoxide against *Taenia saginata* cysticerci in experimentally infected cattle varied according on the routes, doses, and treatment plans used (Lopes *et al.*, 2014). Additionally, praziquantel is not commonly used to treat cattle because it is not approved for the treatment of bovine cysticercosis, would be highly expensive given the weight of the animals, and also poses the risk of reinfection the following day (Parkhouse and Harrison, 2014).

Albendazole is frequently used in Ethiopia to treat nematode and trematode diseases, but not bovine cysticercosis because the dosage is larger for treating cysticercosis than for nematodes. A cysticercus takes several months to clear following therapy, thus carcasses may still have lesions and be rejected even after the animals have received treatment. The Meat Inspection Act states that the presence of living or dead cysticerci constitutes grounds for condemnation. Mebendazole (50 mg per kg), praziquantel (50 mg per kg), and albendazole (50 mg per kg) are some of the compounds that can be used to treat animals, however, they are not thought to be completely successful (Symth, 1994; Soulsby, 1982).

2.12. Control and Prevention

Breaking the life cycle involving the intermediate host of cattle and the final host of humans is crucial for *Taenia saginata* taeniosis and bovine cysticercosis to be under control. The suggested methods for controlling taeniosis and bovine cysticercosis include effective diagnosis and treatment of human carriers, improved meat inspection, and as a long-term intervention program, improved sanitation and sewage treatment, changes in cattle husbandry, and public health education of target groups, including improving culinary habits (Pawlowski *et al.*, 2005).

Infection in cattle can be avoided by using controlled grazing rather than sewage effluent as a pasture fertilizer (Symth, 1994). The prevention of human infection involves comprehensive meat inspection, avoiding consuming raw or undercooked beef (meat should be thoroughly cooked at a temperature of 56 to 60 degrees Celsius), and freezing the contaminated carcass at -10 degrees Celsius for ten days. One of the most important aspects of reducing tapeworms is the treatment of taeniosis carriers (Pawlowski *et al.*, 2005).

Proper detection and encouragement of people to take adequate anthelmintic therapy are crucial in endemic regions like Ethiopia, where numerous tapeworm carriers are using traditional remedies. Additionally, it's crucial to regulate the stool after treatment because ejected worms and proglottids from treated people may pollute the environment. After therapy, the proglottids that were evacuated with the stool need to be appropriately collected and disposed off. Additionally, re-infection may happen after treatment, therefore management of tapeworm carriers must include both therapy and health education to promote safe cooking of meat (Abunna *et al.*, 2008).

All meat, offal, and blood from a highly infected animal must be condemned during the meat inspection process. A severe infection can be described in a variety of ways, but often it involves the discovery of cysts at two of the predilection locations as well as two sites in the legs. The contaminated areas and surrounding tissues are excised and condemned in the event of a less severe infection. The carcass and edible viscera must be treated even if there is just one dead cyst present, and this is justified because roughly 10% of lightly infected carcasses had both dead and viable parasites present upon dissection (OIE, 2008).

According to OIE (2018), for meat with light infection, including those carrying one dead cysticerci the infected part and the surrounding tissue have to be condemned. In Ethiopia, carcasses with light infection are supposed to be treated as mentioned above, and those carrying 6-20 cysticerci need mandatory cooking. Health education as a long-term control and prevention method of *Taenia saginata* taeniosis and bovine cysticercosis could be important in communities in endemic areas, by creating awareness of the life cycle and the public health and economic impacts of the parasite (Sanchez and Fairfield, 2003).

The main barriers to the control of the disease in Africa are a lack of adequate taenicides and inadequate health education (Rabi'u *et al.*, 2010). The thermal death point of cysticerci is 57°C, so in developed nations; thoroughly cooking meat is a common practice. Other preventive measures include strict attention to personal hygiene, environmental sanitation, and protecting cattle from contact with human excretion. These include preventing cattle from grazing on feces or sewage-polluted grass and refraining from using untreated human feces as fertilizer (Acha and Szyfres, 2003).

2.13. Public Health Importance

Taenia saginata taeniosis is a very common but neglected infection worldwide, resulting in medical costs, occasionally severe symptoms, and the possibility of psychological distress for tapeworm carriers. Despite the low global burden of taeniosis, which is attributed to the fact that deaths and disability caused by taeniosis are likely to be rather negligible, the infection still requires medical attention (Torgerson, 2013). Bovine Cysticercosis is the larval form of the tapeworm *Taenia saginata*, often known as the beef tapeworm, which is responsible for the food-borne parasitic zoonosis known as cysticercosis. Because of the meat-borne nature of this larva, eating raw or undercooked beef might cause human infection. Only in the small intestine of humans does the mature *Taenia saginata* reside. The number of worms present affects the size that the adult worm reaches (Maedia *et al.*, 1996).

2.14. Economic Importance

Cysticercosis in cattle is a significant food safety issue and causes economic loss in food production. Efforts to reduce the prevalence of *Taenia saginata* in humans and their cysticerci in cattle may have a significant impact on the economics of meat production industries. This will be particularly important where export industries are involved, as most importing countries have strict regulations designed to prevent the importation of infected meat (Harrison *et al.*, 2001). For the African continent, an annual loss of US\$ 1.8 billion under an overall infestation rate of 7% was reported (Kumar and Tadesse, 2011).

Economic losses from cysticercosis are determined by disease prevalence, grade of infected animals, potential market prices of cattle, and treatment costs for detained carcasses. The economic losses associated with bovine cysticercosis are primarily caused by condemnation resulting from heavy infestation with the *Taenia saginata* cysticerci as well as the cost of inspecting meat, freezing or boiling infected meat, and losses may also occur from restrictions on exports of live animals and animal products, whereas adult worm illness in humans results in high medical costs (Belachew and Ibrahim, 2012).

In contrast, medical costs including the cost of treatment, medical consultations, and laboratory tests have been estimated in some industrialized countries (Blagojevic *et al.*, 2017). Light infection or localized cysticercosis results in condemnation of the infected parts; additionally, the carcass must be kept in cold storage at a temperature not exceeding -7°C for up to 3 weeks to inactivate the parasites (Abuseir *et al.*, 2006). Economic losses in the meat business are closely linked to the level of illness. It is very challenging to evaluate the economic impact of taeniasis/cysticercosis, particularly in developing countries such as Ethiopia where relevant data are scarce and a significant proportion of afflicted individuals self-medicate with traditional herbal medicines such as "Kosso" and other drugs (Abunna *et al.*, 2008).

The costs associated with treating human taeniasis and cattle corpses (cost of freezing, boiling), as well as the costs associated with the inspection procedures, can be broken down into the economic impact of the disease in terms of cost implications and amount to millions of dollars (Nunes, 2003). The economic impact of human taeniasis caused by *Taenia saginata* is due to treatment costs and/or the number of sick days, and long-term effects. Recently Jansen *et al.*, (2018) reported a maximum estimated loss of 795,858 per year from 10,991 taeniasis patients in Belgium, which is related to medication cost, cost of diagnosis, and consultation. Since self-medication for gastro-intestinal tract diseases is a common practice in Ethiopia (Ayalew, 2017), the costs for medication, diagnosis, and consultation per person might be lower compared to the Belgian estimate. On the other hand, earlier reports from Africa showed a total loss from bovine cysticercosis in Botswana to be nearly £0.5 million per year while in Kenya it was £1 million (Grindle, 1978). In Iran, the direct economic loss from bovine cysticercosis was estimated to be US\$ 112,302 (Hashemnia *et al.*, 2015).

3. MATERIALS AND METHODS

3.1. Description of the Study Area

The study was conducted at Halaba Kulito; municipal abattoir, General Hospital, Health Center, private pharmacy, and surrounding areas of Halaba Kulito town, Central Ethiopia Regional State. Halaba Kulito town is the capital city of Halaba zone which is located in the Central Ethiopia Regional State, at a distance of 310 km from Addis Ababa the capital city of Ethiopia, and 106 km from Hossana town. The study area is found within an altitude ranging from 1554 to 2149 m above sea level, and an astronomic location of 38°7'0"E longitude and 7°18'0"N latitude. It is generally characterized by dry climatic conditions with about 86% mid-land (Weinadega) and 14% low-land (Kola) zones. The mean annual rainfall of the study area is ranging from 857 to 1085 mm, while the mean annual temperature varies from 17 to 20°C with a mean value of 18°C (Ketema *et al.*, 2009). The livestock populations of the study area are about 293,930 Cattle, 137,929 Sheep, 195,503 Goats, 332,079 Poultry and 60,471 Equine (HZARDO, 2023).

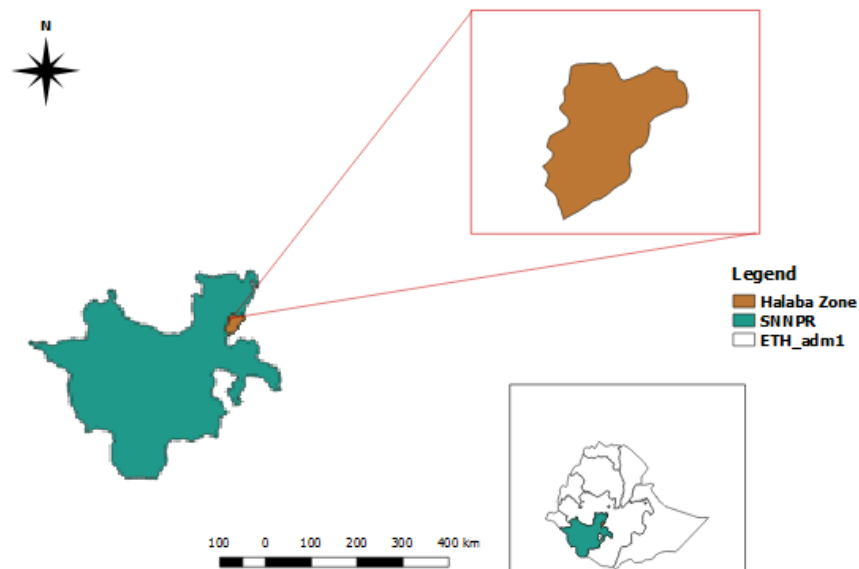


Figure 2 : Map of Ethiopia depicting the location of the study area(Halaba zone)(Source; QGIS)

3.2. Study Population

The study population is the population from which a sample is drawn and target population is the total population about which information is required. And the breeds of the study animals were both indigenous zebu cattle and cross breeds of zebu with Holstein-Friesian. Most of the slaughtered animals were male cattle. They were brought from different districts of Halaba zone (Wera, Atoti ullo, and Wera Dijo districts), and surrounding areas of Eastern Badawacho (Shone) and Rope districts for slaughtering purposes. Both sexes of adult and old age groups were selected. The average minimum and maximum numbers of cattle slaughtered at Halaba Kulito municipal abattoir during the study period per day were 15-30 respectively. The animals were transported to the abattoir using vehicles or on foot depending on the distance and origin of the animals. After the animals arrived at the abattoir, ante mortem examinations were carried out for every animal. During the sampling of the study animals, risk factors like origin, sex, age, breed, and body condition score of the animals were recorded. Finally, at midnight, detailed post-mortem examinations were done and the result obtained was recorded on the format sheet. Volunteer participants in and around Halaba Kulito town were used for questionnaire surveys. They were drawn from public servants, butchers, farmers, and merchants.

3.3. Study Design

A cross-sectional study was conducted at Halaba Kulito municipal abattoir from January to June 2023. A retrospective study on five years of data was also conducted at health institutions of Halaba Kulito town (Halaba Kulito General Hospital, Health Centre, and drug shop inventory) from January 2019 to August 2023. In addition to these, a questionnaire survey was also applied to randomly selected individuals. Systematic random sampling techniques were used to collect all the necessary data from the abattoir survey of the study animals since it involves selection of sampling units at equal intervals. Consequently, the first sample was picked randomly and the interval calculated was used to proceed further to get the calculated sample size for the proposed study.

3.4. Sample Size Determination

The sample sizes (n) were determined according to Thursfield (2018) by using the following formula.

Thus,

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

Where:-

n= required sample size

P= expected prevalence

d= desired level of precision

(1.96)²=confidence interval of 95%

There was a previous study with an expected prevalence of 8.6% (Abdulaziz *et al.*, 2016) in the study area, after the substitution, 120 cattle were calculated to be sampled. Actually 439 cattle were sampled and inspected during the study period with the intention to increase the level of accuracy of determining the prevalence. For questionnaire survey the sample size was calculated using the formula $N = 0.25/SE^2$ (Arsham, 2015). Where: N = sample size, SE (standard error) =5%. As per the above formula, the sample size required for the questionnaire survey was 100. Therefore, totally 100 individuals were interviewed.

3.5. Study Methodology

3.5.1. Active Abattoir Survey

Systematic random sampling techniques were applied to those 439 slaughtered cattle at the abattoir. Both ante mortem and post-mortem examination were done at (10:00 AM - 12:00 AM) and (03:00 PM- 05:00 PM) in Halaba Kulito municipal abattoir, respectively. The abattoir was visited five days per week and, each selected cattle were given an identification number by writing a code on its rib/back using paint, and four to six cattle were examined on each slaughter

day. The first sample was picked randomly and the interval calculated was used to proceed further to get the calculated sample size for the presumed study, in this case, every sixth cattle entered the slaughtering house after an ante mortem inspection was considered and marked. During ante mortem inspection, both sides of the animals were inspected at rest and in motion. Moreover; the general behaviour of the animals, gait, structure, body condition, and signs of disease and abnormalities of any type were registered. Animals, depending on their body condition, were ranked into nine groups (Nicholson and Butterworth 1986) Anex 5; but in our research cause we use two groups such as good and medium body condition score.

The age of the animals was determined by the dentition (De La hunta and Habel 1986) formula and categorized into three age groups (<5 years, young, 5-10 years, adult and > 10 years old). Accordingly, all animals usually brought for slaughtering belonged to the adult and old age groups. During the study period, bovine carcasses were examined for the presence of *Cysticercus bovis* following the customary meat inspection procedure stipulated in the Minister of Agriculture Meat Inspection Regulation (MOA, 2015).

According to the guideline, the carcass was inspected by visualization, palpation, and making systematic incisions where necessary for the presence of cysts, and the tongue was ventrally incised from tip to the root longitudinally, deep liner incisions of the masseter muscle parallel to the mandible were made, and four to six incision were made in each organ for inspection. The heart was incised from base to apex to open the pericardium and incision also made in the cardiac muscle for detail examination. In the shoulder muscles, deep, adjacent, and parallel incisions were made above the point of the elbow. Examination of the liver, and the lung was also conducted accordingly, and all necessary information and the results obtained were recorded.

3.5.2. Cyst Viability Test

The cysts were appropriately collected, labelled, and brought after five to seven hours to Wolaita Sodo Regional Veterinary Laboratory institute, using an icebox for further investigations, and all the cysts from affected organs were carefully trimmed off with surrounding tissues.

First, the viability of cysts was examined by 40% Ox bile diluted in a normal saline solution and incubated at 37°C. Evagination of the unarmed scolex in viable cysts usually occurs within 1-2 hours (Gracey *et al.*, 2015). The cysts were then identified by microscope as *Cysticercus bovis* if they lack hooks and rostellum on the evaginated scolex with four suckers (Opara *et al.*, 2006).

3.5.3 Questionnaire-Based Investigation

First the objectives of the survey were explained to the respondents before the start of the interview and then verbal consent was obtained from the respondents. The questionnaire was prepared in English, after which it was later translated to either ‘Amharic or Halabisa depending on the language of the participant. The identification of respondents for the questionnaire survey was based on a random selection of volunteers of different sex, age and from different social groups like, public servants, butchers, farmers, and merchants from Halaba Kulito town and surrounding areas. A questionnaire survey on the disease occurrence and risk factors was registered on those 100 volunteer respondents from whom informed consent was obtained.

Community awareness on the use of latrine, raw meat consumption habits, knowledge of taeniasis, source of information on the diseases, use of drugs for treatment, awareness of the route of transmission, and knowledge on prevention mechanism was incorporated in the questionnaire. Specific questions regarding medical history related to the use of traditional and modern taeniocidal drugs, impacts of taeniasis, and possible options were included in the questionnaire. The potential risk factors of tape worm/taeniasis such as the habit of raw meat consumption, age, sex, religion, occupation, educational levels, presence and usage of sanitary facilities especially toilets, and knowledge of *Taenia saginata* and its zoonotic importance and other necessary information were collected through face-to-face interviews with the respondent and all information were recorded on the questionnaire format sheet.

3.5.4 Retrospective Data Survey From Health Institutions

A retrospective Hospital and Health Center diagnostic laboratory result survey was carried out based on the review of daily laboratory record findings of stool examination reports of suspected patients (patients with symptoms of abdominal discomfort or pain) who visited Halaba Kulito General Hospital and Health Centre from January 2019 to August 2023. Diagnostic laboratory results were reviewed through patients' files, and the relevant five-year data were collected from the Hospital and Health Center, Parasitology Laboratory record book. The suspected patients were both male and female under different age categories suffering from gastrointestinal disturbance and attended medical treatment in the study Hospital and Health Center. Information on several patients examined sex, age, and stool results of each year were collected. The routine stool examination technique employed in the laboratory was the direct smear saline solution technique. A stool containing egg of *Taenia saginata* in suspected patients that come to the Hospital and Health Center was taken as positive and recorded on the case book.

3.5.5 Inventory of Pharmaceutical Shops

Regarding the drug inventory, the relevant five-year data survey from Halaba Kulito General Hospital and Health Centre drug stores, and seven private pharmaceutical shops were gathered. A five-year dose of taenicial drug sales (based on prescription and patient complaints) and cost from January 2019 to August 2023 were gathered and analysed by descriptive statistics and then the financial loss of tape worm/taeniasis infections were known in the study area.

3.5.6. Estimation of Direct Financial Loss

Annual financial loss due to *Cysticercus bovis* in cattle was estimated from the cost of organs condemned (tongue, heart, liver, and lung). Accordingly, the economic values of the loss from organ condemnations were evaluated by considering the following parameters.

1. Information on the mean retail market price of organs (tongue, heart, liver, and lung) at Halaba Kulito town obtained from butchers during the study period and
2. Retrospective survey of the last 1 year's data was obtained from recorded cause book and the loss from organ condemnations was calculated using descriptive statistics.

3.6. Data Management and Analysis

All the data collected from inspected cattle at the abattoir were entered into a Microsoft Excel 2016 Spreadsheet program and coded before analysis. Statistical analysis was performed with STATA version 14.2 (Stata Corp, 4905, Lake way Drive, College Station, Texas, USA). The overall prevalence or the proportion of positivity per risk factor was calculated as the number of positive animals divided by the total number of animals examined. Potential risk factors for *Cysticercus bovis* such as sex, age, breed, origin, and body condition score were tested for association by using Pearson's chi-square test (χ^2). Other analysis steps used descriptive statistics. In this analysis, statistical significance was set at $P < 0.05$. The anatomical distribution of *Cysticercus bovis* and cyst viability were tabulated. The retrospective Hospital and Health Center data survey were also summarized and tabulated. Questionnaire survey data were also analysed using the Pearson Chi-square test. Pharmaceutical drug inventory data and organ condemnation of financial losses assessment were calculated using descriptive statistics.

4. RESULTS

4.1. Prevalence and Organ Distribution of Bovine Cysticercosis

Out of the total 439 (403 male and 36 female) cattle slaughtered and inspected at Halaba Kulito municipal abattoir, 21 (4.8%) were infected with various numbers of *Cysticercus bovis* found in different organs and muscles (shoulder and masseter muscles, heart, tongue, liver, and lung). The observed result is significantly associated ($\chi^2=7.12$ $p<0.05$) with the age categories of the animal, with the higher prevalence (8.2%) being recorded in old age groups (>10 years), while lower 2.6% was recorded for adult age group (5-10 years). In this study, the body condition score of cattle was not significantly associated ($\chi^2=0.11$, $p>0.05$) with the detection of *Cysticercus bovis* as 5.43% of the cases were in animals with medium body condition while 4.61% were in a good body condition score (Table 2).

This study also revealed that there were no significant associations observed regarding to sex, breed, and origin of the animals ($P>0.05$). While *Cysticercus bovis* was detected in 5.21% of male cattle slaughtered, none of the slaughtered female cattle had *Cysticercus bovis*. Likewise, 5.48% of the local breed cattle brought to slaughter had the cyst in their body, and none of the cross-breed cattle had the cyst. Regarding the origin of animals, there was no significant association ($P>0.05$) with the finding of *Cysticercus bovis*. The prevalence was 6.4% for animals brought from Halaba, 4.7% for animals originating from Eastern Badawacho (Shone), and 3.6% for animals coming from the Rope area as shown in (Table 2).

Table 2: Prevalence of *Cysticercus bovis* in Relation with Sex, Age, Breed, Origin, and Body Condition Score of the Animals

Risk factors	No. of examined	No. of positive	Prevalence (%)	χ^2	P-value
Age				7.12	0.008
Adult (5-10 years)	268	7	2.6		
Old(>10 years)	171	14	8.2		
Sex				1.97	0.159
Male	403	21	5.21		
Female	36	0	0		
Body condition score				0.11	0.459
Good	347	16	4.61		
Medium	92	5	5.43		
Breed				1.9	0.167
Local	404	21	5.48		
Cross	35	0	0		
Origin				1.03	0.742
Halaba	110	7	6.4		
Eastern Badawacho	190	9	4.7		
Rope	139	5	3.6		
Total	439	21	4.8		

4.2. Anatomical Distribution of Cysts

Out of 21 infected cattle, the most frequently affected organ with the highest number of cysts was the tongue 7 (33.3%) followed by heart 5 (23.8%), masseter muscle 3 (14.3%), liver 3 (14.3%), shoulder 2 (9.5%) and the lung 1 (4.8%) as indicated in (Table 3). In each inspected organs four to six incision were made.

Table 3: Prevalence, Frequency and Distribution of *Cysticercus bovis* in Different Organs and Tissues of Affected Animals

Organs Examined	No. of infected organ	Prevalence (%)	Proportion from infected organs	No. of cysts counted	Cyst distribution per organ
Tongue	7	1.6	33.3	12	36.4
Heart	5	1.2	23.8	9	27.3
M. muscle	3	0.7	14.3	4	12.1
Liver	3	0.7	14.3	5	15.2
Shoulder	2	0.4	9.5	2	6.0
Lung	1	0.2	4.8	1	3.0
Total	21	4.7	100	33	100

4.3. Cyst Distribution and Characterization

From the total of 33 cysts that were counted during an inspection from the abattoir, 4 (12.1%) were found viable, 8 (24.3%) were non-viable, and 21 (63.6%) were found calcified. The viability test of the cysts revealed that viable cysts were detected from the tongue, shoulder, and masseter muscle as indicated in (Table 4).

Table 4: Proportion of Viable, Non-viable and Calcified Cysts Inspected in Different Organs

Organ inspected	Condition of Cysts			
	Total number of cyst examined	Viability-and Percentage	Non-viability and Percentage	Calcified and Percentage
Tongue	12	2(16.7)	2(16.67)	8(66.7)
Heart	9	0(0.0)	1(11.12)	8(88.9)
Liver	5	0(0.0)	2(40)	3(60.0)
Masseter muscle	4	1(25.0)	2(50)	1(25.0)
Shoulder muscle	2	1(50)	0(0.0)	1(50.0)
Lung	1	0(0.0)	1(100)	0(0.0)
Total	33	4(12.1)	8(24.3)	21(63.6)

4.4. Estimation of Financial Loss Due to Organ Condemnation

Direct financial losses due to organ condemnation from slaughtered cattle at Halaba municipal abattoir from July 2022 to June 2023 were assessed. Based on this one-year retrospective data, a total of 5 organs (3 tongues, 1 heart, and 1 liver), were totally condemned. In addition to these, a total of 18 tongues, 15 hearts, 9 livers, and 2 lungs, were partially condemned due to *Cysticercus bovis* which corresponds to a financial loss of 1,440 Ethiopian Birr ETB, 850 ETB, 2,750 ETB, and 40 ETB, from each organ, respectively accounting to a total of 5,080 ETB. This was determined from the average market price of cattle tongue (120 Birr), heart (100 Birr), liver (500 Birr), and lung (40 Birr) in Halaba Kulito town during the study period; and for partial condemnations 50% of the organs was lost according to the informations obtained from meat inspector.

4.5. Inventory of Pharmaceutical Shops in Halaba Kulito Town

Estimates of yearly taeniocidal drug doses and their worth were collected through personal face-to-face interviews with pharmacists using their recorded data and invoices from January 2019 to August 2023. The result of this inventory revealed that a total dose of 379,707 taeniocidal drugs worth 2,823,766 ETB or (48,685.5 USD; 1USD~55.75 ETB) was estimated on average within five years for the treatment of human taeniasis in the current study area. A relatively high dose of albendazole tablet (74.6%) followed by praziquantel tablet (20.6%), albendazole suspension (3.4%), and niclosamide tablet (0.4%) was sold as indicated in (Table 5).

Table 5 : Inventory of Pharmacies Supplying Taeniocidal Drugs in the Study Areas Showing Annual and Total Estimated Cost from January 2019 to August 2023

List of drugs	Year, Total Dose and Total Price in Ethiopian Birr					Dose and Price
	2019	2020	2021	2022	2023	
Praziquantel	4,800 dose 19,850 birr	13,000 dose 75,125 birr	22,000 dose 200,050 birr	21,200dose 419,825birr	17,200dose 309,600birr	78,200 dose 1,024,450 birr
Niclosamide	1,500 dose 9,157 birr	—	—	—	—	1,500 dose 9,1567 birr
Albendazol Tablet	83,200 dose 303,011 birr	55,900 dose 230,615 birr	45,700 dose 238,455 birr	60,200dose 435,037birr	38,400dose 310,925birr	283,400 dose 1,518,043 birr
Albendazole suspension	2,179 dose 31,595.5 birr	2,018 dose 29,765 birr	2,722 dose 53,759.5birr	3982 dose 98,554.5birr	2,106 dose 58,441.5birr	13,007dose 272,116 birr
Total	91,679dose 363,613 birr	70,918 dose 335,505 birr	70,422 dose 492,264 birr	85,382dose 953,417birr	57,706dose 678,966birr	379,707 dose 2,823,766 birr

4.6. Questionnaire Survey Result

Out of 100 voluntarily interviewed respondents who participated in this study in Halaba Kulito town and surrounding areas, 64 (64%) said that they had a history of getting infected with *Taenia saginata* at least once in their lifetime. The respondents also confirmed human taeniasis witnessing that they had observed proglottids in their feces. Among the respondents, 47% knew the considered risk factors of infections leading to taeniasis. Residences of respondents had no significant association ($\chi^2= 0.599$; $P>0.05$) with reported occurrence of taeniasis. Accordingly, 58.8% of the rural residents interviewed had the infection while 66.7% of the urban residents also reported the infection (Table 6).

Similarly, the occurrence of infection did not show a statistically significant ($\chi^2=0.029$; $p>0.05$) association with the religion of the interviewees where 63.33% and 65.00% of the respondents who had a history of infections were Muslim and Christian faith followers, respectively (Table 6). Nevertheless, a statistically significant ($\chi^2= 6.41$; $p<0.05$) association was revealed between the sex groups of respondents only 47.1% of the females had infections while it was 72.7% of male respondents. The study also revealed that there was a significant association ($\chi^2=5.39$; $p<0.05$) among different age groups of the respondents with a relatively higher infection rate (73.68%) reported in the adult age group while a lower infection rate (51.16%) being for the young age groups (Table 6).

The finding from this study also revealed that the history of occurrence of taeniasis among respondents was found to be associated significantly ($\chi^2=5.39$; $p<0.05$) with consumer preference that all individuals (100%) preferring raw meat consumption had the infections while only 34.5% of those who prefer cooked meat responding had infections previously. Based on education level, the prevalence was 65.4% (17/26) for illiterate, 75% (36/48) for mid-level, and 42.3% (11/26) for Tertiary level. Similarly, the occupation status of the respondents was found to be associated significantly ($\chi^2=13.39$; $p<0.05$) which had also been found to link with the frequency of occurrence where it was 88% (22/25) in butchers, 64% (16/25) in farmers, 64% (16/25) in merchants, and 40% (10/25) in public servants. Most exposed individuals to taeniasis (55%) mentioned that they took modern anthelmintic drugs as treatment, while 9% of the

individuals used traditional herbs and 36% of the individuals had never used any kind of taeniocidal drug (Table 6).

Table 6 : Community Awareness/Knowledge about Association of Studied Factors With Risk of *Taenia saginata* Contraction in and Around Halaba Kulito town.

Risk factor	Category	Interviewed	Infected by <i>teania</i>	Prevalence	χ^2	P-value
Residence					0.599	0.288
	Rural	34	20	58.82		
	Urban	66	44	66.66		
Sex					6.41	0.011
	Male	66	48	72.72		
	Female	34	16	47.06		
Age					5.39	0.017
	Young	43	22	51.16		
	Adult	57	42	73.68		
Religion					0.029	0.52
	Muslim	60	38	63.33		
	Christian	40	26	65.00		
Meat consumption habit					46.02	0.00
	Raw	45	45	100		
	cooked	55	19	34.54		
Occupation					13.39	0.01
	Merchant	25	16	64		
	Farmer	25	16	64		
	Abattoir worker	25	13	52		
	Butcher	25	22	88		
	Public servant	25	10	40		
Educational level					4.32	0.23
	Illiterate	34	21	61.76		
	Primary	37	27	73		
	Secondary	23	14	60.9		
	Tertiary	31	15	48.4		

4.7. Retrospective Data Survey From Health Institutions

Data obtained from Halaba Kulito General Hospital and Health Center referring patient record book registered in a period from January 2019 to August 2023 to estimate the status of *Taenia saginata* based on their age, sex and year of examination revealed the following result. Out of a total 40,993 (17,339 males and 23,654 females) patients examined using stool samples in five years, a total of 112 (0.27%) patient samples were found positive for *Taenia saginata* eggs. Of these patients, 59 (0.34%) were males and 53 (0.22%) were females. With regard to age, higher infections were observed between the ages of 26-50 years, 69 (0.34%), and the lowest was observed between the ages of 10-25 years, 23 (0.19%). The stool examination result also showed that the occurrence of infection was highest in the year of 2019 (0.37%) and lowest in 2023 (0.18%).

Table 7: Retrospective Clinical Case Reported of Human Patients Infected With *Taenia saginata* by Age, Sex and Years in Halaba Kulito General Hospital and Health Center from January 2019 to August 2023.

Variable	No. of Stool examined	No. of <i>T. saginata</i> positive	Prevalence (%)
Age			
10-25	11,614	23	0.19
26-50	20,271	69	0.34
≥51	9,108	20	0.21
Total	40,993	112	0.27
Sex			
Male	17,339	59	0.34
Female	23,654	53	0.22
Total	40,993	112	0.27
Year			
2019	9,820	37	0.37
2020	9,759	24	0.24
2021	9,603	26	0.27
2022	7,964	18	0.21
2023	3,847	7	0.18
Total	40,993	112	0.27

5. DISCUSSION

Taenia saginata/taeniosis and bovine cysticercosis are highly endemic in central and eastern African countries such as Ethiopia (Allan *et al.*, 2005). In this review, high prevalence of taeniosis and bovine cysticercosis recorded in several studies, with substantial variation in the prevalence among the different zones of the country and within the same abattoir at different time points. Within abattoir difference could be primarily attributed to variations in the application of the Ethiopian meat inspection regulation. Based on postmortem inspection the finding of the current study showed that the prevalence of bovine cysticercosis in cattle slaughtered at Halaba Kulito municipal abattoir was 4.8% (21/439).

This result is comparable to other findings in Ethiopia like that of Haben and Isayas, (2023) at the Bishoftu municipal abattoir where they reported a prevalence of 4.24%; Mekonnen (2017) who reported 4.94% at Kofale abattoir and Kifle and Shiret (2015) who reported about 4.46% at Debre Berhan abattoir. However, the present finding was lower compared to the findings of Aragaw *et al.*, (2018) who found 8.97% at Kombolcha abattoir; 9.6% (Netsanet *et al.*, 2020) at Dessie, 15.5% (Bekele *et al.*, 2017) at Ambo, and 26.25% (Abunna *et al.*, 2008) at Hawassa. Moreover, some studies carried out in some African countries also reported a higher prevalence i.e. 33.02% (Onyango-Abuje, 1996) in Kenya than the current finding.

Likewise, the result of the current study was also greater than that of the findings of 2.0% (Ezeddin and Tewodros, 2016) at Gonder, 2.68% (Wabi and Girmay, 2019) at Nekemte, 3.13% (Gizaw and Timotiws, 2022) at Wolaita Sodo, and 3.24% (Samatar, 2021) at Jijgiga municipal abattoir showing the status of distribution in different parts of Ethiopia. However, the occurrence is even very low in some countries in and out of Africa where it was reported as 0.25% in Iran (Khaniki *et al.*, 2009), 0.11% (Zdolec *et al.*, 2012) in Croatia, 1.05% (Dutra *et al.*, 2012) in Brazil, 0.2% (Blessing *et al.*, 2011) in South Africa, 0.37% (Rodriguez Hidalgo *et al.*, 2003) in northern Ecuador, 0.23% (Haridy, 1999) in Egypt, and 0.9% (Sau'rez and Santizo, 2005) in Cuba.

The variation likely arises from differences in the animal management system, changes in environmental and epidemiological factors, or variations in sample size. Long-term survival in the external environment is possible for *Taenia saginata* eggs. According to studies, it can stay infectious in the soil for five to nine and a half months (Dorny *et al.*, 2000). Moreover, mildly contaminated carcasses may be overlooked and approved for human consumption since traditional meat inspection methods are less accurate (Minozzo *et al.*, 2002).

Moreover, low number of incisions made at the abattoir inspection site, the practice of consuming raw meat, the status of people in the surrounding area, particularly about proper toilet use, and the viability of the eggs consumed by the animals are likely the causes of the difference (Scandrett *et al.*, 2009). Nearly, 86% of *Cysticercus bovis* were discovered in the skeletal muscles, which are not examined during the regular meat inspection. This finding could perhaps explain why cysts are overlooked during inspection, according to an experimental investigation done by Minozzo *et al.* (2002).

The current study also revealed that there was a statistically significant association ($p < 0.05$) between the detection of *Cysticercus bovis* and the age group of slaughtered cattle. A higher prevalence of 8.2% was observed in cattle aged above 10 years old than in adult cattle aged in the range of 5-10 years group (2.6%). This is in agreement with the work of Wondimagegn and Belete (2015) who reported a higher prevalence of *Cysticercus bovis* in cattle of the old age group; but disagree with the report of Yimer and Gebrmedehan. (2019). However, Mesfin and Nuraddis, (2012) found no significant variation in prevalence rate in cattle according to the age categoris. This variation might be due to longer exposure of aged cattle to infection by Tapeworm egg from contaminated environment and water.

The detection of *Cysticercus bovis* in the sex of animals was 5.21% in male animals while no cyst was found in female animals slaughtered during the study period. The absence of cyst detection in female animals might be linked to the fact that the sample size variation between female and male cattle slaughtered at different municipal abattoirs and females kept in the herd for breeding and milk production and thus rarely sent to slaughter houses, and most of the femal animals are managed in the house for milking purpose so that the probability of infection is

reduced. According to the current study, the most frequently affected organs with the highest proportion of cysts of *Cysticercus bovis* were recorded in the tongue (33.3%), in the heart (23.8%), in masseter muscles (14.3) and liver (14.3%), in the shoulder (9.5%) and in the lung (4.8%). The finding of the current study is in agreement with the reports of Yimer and Gebrmedehan (2019) and Bedu *et al.* (2011) which showed that the most frequently affected organs with the highest number of cyst counts were the tongue followed by the heart; and also according to the report of Dawit *et al.* (2012) and Tesfay and Assefa (2012), the tongue was the most commonly affected organ with *Cysticercus bovis*.

Of the total 33 cysts collected 12.1% were viable, 24.3% were non-viable, while the rest 63.6% were calcified. This finding greatly varies from the findings in some studies in Ethiopia like that of Emiru *et al.* (2015) who found 66.6% of the cysts detected viable and 33.4% of dead cysts at Elfora abattoir Bishoftu, and Nuraddis (2012) who also found 62.5% of cysts being viable and 37.5% are non-viable at Hawassa municipal abattoir. The fluctuations in the viability rate of *Cysticercus bovis* cysts in various locations may stem from variations in the immune responses of infected cattle or from variations in the cattle owners' management practices, particularly in the routine use of anthelmintic drugs for deworming their animals (Daryani *et al.*, 2007).

However, the viability test of the cysts revealed that it was the shoulder muscle that harbored the highest number of viable cysts (50%), followed by the masseter muscle (25%) and tongue (16.7%), and while the cyst in the heart, liver, and lung were found degenerated with 0% viability rate. Variations in the anatomical distribution of the viable cyst are dependent on several factors, including blood kinetics (mostly in muscles with high blood supply because of everyday activities of animals and often times organ movement). According to Gracey. (1986), the distribution of oncospheres is influenced by any environmental and geographic elements that impact the animal's blood dynamics. In contrast to muscle cells, hepatic cells undergo a variety of metabolic processes that may inhibit the growth and survivability of *Cysticercus bovis* cysts located in the liver, hence influencing cyst occurrence and viability (Nuraddis and Frew 2012).

The present study also covered an assessment of human taeniasis based on five years of retrospective data survey (from January 2019 to August 2023) at Halaba Kulito General Hospital

and Health Center revealed that 112 (0.27%) cases were found positive for *Taenia saginata* egg. This finding is lower than the report of Yimer and Gebrmedehan (2019) who reported 3.9% in and around Debre Brihan referral hospital in Ethiopia, but higher than the report of Tegegne *et al.* (2018) who reported 0.07% at Kombolcha town. The variations in the prevalence of *Taenia saginata* egg detection could be attributed to the consumption of raw or undercooked beef, public awareness of the parasite's origin and route of transmission, and personal and environmental cleanliness.

Additionally, self-medication or the use of traditional remedies may be the reason for the low prevalence of taeniasis in the research area. The prevalence of *Taenia saginata* egg detection about the sex of patients showed that a relatively higher prevalence was seen in males (0.34%) compared to females (0.22%). This observation is similar to the finding of Abunna *et al.* (2008) who reported a higher prevalence of taeniasis among males than females in Hawassa town. The difference is might be due to males tend to consume raw beef more frequently than ladies outside, which may be the cause of their higher prevalence of *Cysticercus bovis*. Additionally, males tend to consume raw meat more frequently than females on holidays and other ceremonial occasions.

The findings of the questionnaire survey on volunteer respondents in and around Halaba Kulito town showed an overall infection rate of 64% and this was comparable with the findings of Abunna *et al.* (2008) who reported a prevalence of 64.2% at Hawassa town, 64.55% (Solomon, 2023) in Silte zone, 64% (Lielt *et al.*, 2015) in Bishoftu, and 62.5% (Dawit *et al.*, 2012) in Wolaita Soddo. However, the present finding was greater than the finding of Mesfin and Nuraddis (2012) who reported 44% in Hawassa town, 22.5% (Netsanet *et al.* (2020) in and around Dessie, 13% (Samatar, 2021) in Jigjiga town, but lower than the finding of Hailu (2005) who reported the prevalence of 79.5% in Eastern Shoa, 70% (Abunna, 2013) in Yirgalem town and 89.41% (Tembo, 2001) in different agro-climatic zones of Ethiopia. These variation of taeniasis in different areas might be associated with the difference in occurrence of cysticercosis in cattle, the level of raw meat consumption culture among societies, the meat inspection procedures and backyard slaughter practice. On the other hand, the reason for this variation may be related to the level of environmental contamination and degree of awareness of different

societies about taeniasis transmission. This study also showed that males were highly affected (72.7%) than females (47.06%). This finding is similar to the finding of Lielt *et al.* (2015) at Bishoftu, who reported a higher prevalence of taeniasis among males than females. The reason for these variation is similar to described as above in the cause of Hospital and health center. This study also showed that relatively higher infections were seen in adults (73.7%) than young (51.2%) age group. This finding is similar to the report of Lielt *et al.* (2015) at Bishoftu, Dawit *et al.* (2012) at Wolaita Soddo, and Dejene (2017) at Ambo municipal abattoir.

This may be because adults are more likely to eat raw meat contaminated with *Cysticercus bovis* at various events, such as cultural ceremonies where raw meat is served as a main course, while younger age groups typically do not have access to this, or because young people cannot afford to eat raw beef in a butcher shop due to economic reason. In this study, the prevalence of taeniasis was 100% for raw meat consumers but only 34.54% for cooked meat consumers. This finding is in agreement with the report of Megersa *et al.* (2009) at Jimma municipal abattoir. This might be due to inadequate meat inspection protocols, backyard slaughtering techniques, and the long-standing cultural custom of consuming raw meat, especially "kurt" and "kitifo" in numerous socio economic groups. Because of this, people who eat raw meat are much more likely than those who eat cooked meat to have taeniasis illness.

Furthermore, inventory of eight pharmaceutical shops, one Hospital, and Health Center drug stores which comprise of five years data during the study period showed that about 379,707 doses of taenicial drugs with an estimated cost of 2,823,766.5 ETB or (48,685.5 USD) was spent on average within five years for the treatment of human taeniasis in the study area. The present finding is greater than the finding of Megerssa *et al.*, (2010) who reported an average cost of 111,353 ETB (11,135.3USD) per annum at Jima, and Abdulaziz *et al.*, (2016) reported 95,181 ETB (4642.97USD) per annum at Halaba Kulito town. The variation might be due to long duration of study period, cost of individual drugs sold in the pharmacies, or population density. The costs associated with partial or total condemnation of the infected organs were estimated a total of 5,080 ETB lost annually due to *Cysticercus bovis* infections. This amount of money estimated due to partial condemnations of organs was very low since mostly light infection was detected during post-mortem inspection in the abattoir during the study period.

6. CONCLUSION AND RECOMMENDATIONS

The current study is based on abattoir data, retrospective records from health institutions as well as questionnaire survey findings which indicate that *Cysticercus bovis*/*Taenia saginata* was important in terms of its economic and public health implications in the study area. The present study show that *Cysticercus bovis* is prevalent in cattle slaughtered at the Halaba Kulito municipal abattoir. Animal organ distribution of viable *Cysticercus bovis* cysts in slaughtered cattle showed a serious threat to raw beef consumers who are at risk of contracting the disease and dispersing eggs through indiscriminate defecation. Taeniasis seems to be a significant problem in the current study area despite the low rate of diagnosis in humans due to the little effort of individuals going to health institutions for the parasite and the attempts of self-medication in society. Ultimately, the results of these researches highlight the significance of taeniasis and cysticercosis from an economic and public health perspective, and they call on the various stakeholders to give these diseases significant consideration to protect society from infections.

Based on the above conclusions, the following recommendations were forwarded:

- ❖ It is important to consider integrated community-based control techniques, which include raising community awareness to consume well-cooked meat and avoid raw or undercooked meat from consumption and other risk factors associated with them.
- ❖ It should also be suggested to improve hygienic conditions by using latrines and regularly inspecting the meat of animals that have been slaughtered.
- ❖ It is strongly advised to coordinate one health intervention.

7. RERERENCES

- Abdulaziz, H., Tilahun, B., and Moa, M. (2016): Study on *Bovine* cysticercosis with special attention to its prevalence, economic losses and public health significance in and around Halaba Kulito Town, South Ethiopia. *World J Agric Sci*; **12**: pp: 299-307.
- Abunna, F. (2013): Prevalence, organ distribution, viability and socioeconomic implication of bovine cysticercosis/teniasis, Ethiopia. *Rev Livest Vet Med Trop Ctries* **66** (1): pp: 25-30.
- Abunna, F., Tilahun, G., Megersa, B., Regassa, A., and Kumsa, B. (2008): Bovin Cysticercosis in Cattle Slaughtered at Hawassa Municipal Abattoir, Ethiopia: Prevalence, Cyst Viability, Distribution and Public Health Implication. *Zoonosis PubHlth.*, **55**: pp; 82–88
- Abusier, S., Epe, T., Schneider, G., and Klein, M. (2006): Visual Diagnosis of *Taenia saginata* Cysticercosis during meat inspection. *Prasitol. Res.* **99**: pp: 405-409.
- Acha, P. and Szyfres, B. (2003): Zoonoses and communicable Disease common to human and Animals. 3rd ed. Volume 3: Parasitizes. Washington, D.C; *Pan American health Organization*, pp: 166-214.
- Ahmed, I. (1990): Bovine Cysticercosis in animals slaughtered at Nekemte abattoir, Addis Ababa University, faculty of veterinary medicine, Debre Zeit, Ethiopia.
- Allan, J., Avila, G., Brandt, J., Correa, D., Del Brutto, O. and Dorny, P. (2005): Guidelines for the Surveillance, Prevention and Control of Taeniosis/Cysticercosis, WHO/FAO/OIE Guidelines for the surveillance, prevention and control of taeniosis/cysticercosis.
- Alemayehu, R., Hailu, F., Gadisa, M. and Biniyam. (2009): Cysticercosis of slaughtered cattle in Wolaita Soddo, Ethiopia. *Research of Veterinary Sciences*, **47**: pp: 322-346.
- Aragaw, T., Adem, H. and Kemal, K. (2018): Bovine cysticercosis and human taeniasis: Animal–human health and economic approach with treatment trends in Kombolcha Town, Wollo, Ethiopia. *Int J One Health*; **4**: pp: 15-21.
- Arsham, H. (2015): Questionnaire design and surveys sampling, survey: The online survey tool, 9th edition. [Http://home.ubalt.edu/ntsbarsh/Business-stat](http://home.ubalt.edu/ntsbarsh/Business-stat).
- Asci, Z., Seyrek, A., Kizirgil, A. and Yilmaz, M. (1998): A retrospective study on the prevalence of *Taenia saginata*. *Eur J Med.* **3**: pp: 10-12.

- Ashwani, K., and Gebretsadik, B. (2008): Occurrence of cysticercosis in cattle of parts of Tigray region of Ethiopia. *Haryana Vet.* **3**: pp: 88-90.
- Assava, L., Kitala, P., Gathura, P., Nanyingi, M., Muchemi, G, and Schelling, E. (2009): A Survey of bovine cysticercosis/human taeniasis in Northern Turkana District, Kenya. *Prev. Vet. Med.* **89**: pp: 197- 204.
- Ayalew, M. (2017): Self-medication practice in Ethiopia: a systematic review. Patient preference adherence. Volume. **11**: pp: 401–413.
- Bedu, H., Tafess, K., Shelima, B., Woldeyohannes, D., Amare, B, and Kassu, A. (2011): Bovine cysticercosis in cattle slaughtered at zeway municipal abattoir: Prevalence and its public health importance. *J Vet Sci Technol*; **2**: pp: 75-79.
- Belachew, M. and Ibrahim, N. (2012): Prevalence of *Cysticercus bovis* in Hawassa Municipal abattoir and its Public health implication American-Eurasian *Journal of Scientific Research*, **7**(6), pp: 238-245.
- Blagojevic, B., Robertson, L., Vieira, Johansen, M., Laranjo, M. and Gabriël, S. (2017): Bovine cysticercosis in the European Union: Impact and current regulations, and an approach towards risk-based control, *Food Control*; **78**: pp: 64–71.
- Blancou, J., Uilenberg, G., Lefevre, P, and Charmette, R. (2010): Infectious and Parasitic Diseases of Livestock. Lavoisier. **2**; pp: 16-46.
- Boone, I., Thys, E., Marcotty, T., Borchgrave, J., Ducheyne, E. and Dorny, P. (2007): Distribution and Bovine Infection with *Taenia saginata* Eggs: Recovery Rates and Cysticerci Location. *Braz. Arch. Biol. Tech.* **45**; pp: 4-8.
- Cabaret, J., Geerts, S., Madeline, M., Ballandonne, C. and Barbier, D. (2002): The use of urban sewage sludge on pastures: The cysticercosis threat. *Vet. Res.*, **33**; Pp: 575–597.
- Chamavit, P., Sahaisook, P. and Niamnuy, N. (2011): The majority of cockroaches from the Samutprakarn province of Thailand are carriers of parasitic organisms. *EXCLI J.* **10**, pp: 218–222
- Chomel, B. (2008): Control and prevention of emerging parasitic zoonoses. *Int. J. Parasitol.* Oxford, **38** (11), pp: 1211–1217.
- Craig, P. and Ito, A. (2007): Intestinal cestodes. *Curr Opin Infect Dis.* **20**; pp: 524–532.
- CSA, (2022): Federal Democratic Republic of Ethiopia, agricultural sample enumeration statistical abstract. Addis Ababa, Ethiopia. Central Statistical Authority

- Daryani, A., Alaei, R., Arab, R., Sharif, M., Dehghan, M. and Ziaei, H. (2007): The prevalence, intensity and viability of hydatid cysts in slaughtered animals in the Ardabil province of Northwest Iran. *J Helminthol* **81**(1): pp; 13-17.
- Dawit, S. (2004): Epidemiology of *Taenia saginata* taeniasis and cysticercoids in north Gondar zone, north western Ethiopia. DVM Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Debrezeit, Ethiopia.
- Dawit, T., Tewodros, S. and Tilaye, D. (2012): Public Health and Economic Significance of Bovine Cysticercosis in Wolaita Soddo, Southern Ethiopia. *Global Veterinaria*, **9** (5): pp: 557-563.
- De Lahunta, A., and Habel, R. (1986): Teeth applied veterinary anatomy, W.B. Saunders Company, pp. pp: 4-6.
- Dejene, B., Barecha, B. and Mahindra, P. (2017): Studies on the prevalence, cyst viability, organ distribution and public health significance of bovine cysticercosis in Ambo muni abattoir, Western Shoa, Ethiopia. *Journal of Parasitology and Vector Biology* **9**(5); pp:73-80.
- Dorny, P. and Praet, N. (2007): *Taenia saginata* in Europe. *Vet Parasitol.* **149**, pp: 22–24.
- Dorny, P., Brandt, J. and Geerts, S. (2005): Detection and diagnosis. Murrell, K.D. (Ed.) WHO/FAO/OIE Guidelines for the surveillance, prevention, and control of taeniosis/cysticercosis World Health Organization for Animal Health (OIE), Paris pp: 45–50.
- Dorny, P., Praet, N., Deckers, N. and Gabriel, S. (2009): Emerging food-borne parasites. *Vet Parasitol.* **163**: pp:196–206.
- Dorny, P., Vercammen, F., Brandt, J., Vansteenkiste, W., Berkvens, D. and Geerts, S. (2000): Sero-epidemiological study of *Taenia saginata* cysticercosis in Belgian cattle. *Vet Parasitol.* **88**; pp: 43–9.
- Duncan, J. (1984): Department of Vet parasitology the faculty of Vet medicine Addis Ababa Ethiopia. Economic Implications in Awassa Town and its Surroundings, Southern Ethiopia *East Afri. J. Of Pub. Hlth.* **4** (2); pp: 73-79.
- Dutra, L., Giroto, A., Vieira, R., Vieira, T., Marquês, F., Headley, S. and Vidotto, O. (2012): The prevalence and spatial epidemiology of cysticercosis in slaughtered cattle from Brazil Seminal. *Ciências Agrárias, Londrina*, **33** (5); pp: 1887-1896.

- EARO, (2015): Beef Research Strategy. Animal science directorate, Addis Ababa, Ethiopia, pp: 241-243.
- Emiru, L., Tadesse, D., Kifleyohannes, T., Sori, T. and Hagos, Y. (2015): Prevalence and public health significance of bovine cysticercosis at Elfora Abattoir, Bishoftu, Ethiopia. *J Pub Health Epidemiology*, **7**; pp: 34-40
- Ento, S. (2005): Ticks in Ethiopia internet document. Ethiopia. 1sted. Faculty of Medicine Department of Community Health, Addis Ababa University
- Eom, S., Rim, H. (1993): Morphologic Description of *Taenia asiatica* Spp. Korean J Parasitology, **31**: pp. 1–6.
- Ezeddin, A and Tewodros, A. (2016): The occurrence of *Cysticercus bovis* at Gondar ELFORA abattoir, Northwest of Ethiopia. *Journal of Cell and Animal Biology*, **10** (3), pp:16-21
- Fahmy, H., Khalifa, N., Reham, S., Madawy, J., Afify, S., Nagwa, S. and Kandil, O. (2015): Prevalence of Bovine Cysticercosis and *Taenia saginata* in Man: *Journal of Global Veterinaria* **15**; pp:372-380.
- FAO, (2004): Manual of meat Inspection for Developing Countries. FAO, Animal Production and Health, pp: 119-359.
- Ferrer, E. and Gárate, T., (2014): Taeniosis and cysticercosis. In: Bruschi F, editor. Helminth Infections and Their Impact on Global Public Health, Springer, Vienna, pp: 201-27.
- Fetene, F. and Nibret. (2014): Prevalence of Bovine Cysticercosis in Cattle and Zoonotic Significance in Jimma Town, Ethiopia. *Acta Parasitologica Globalis* **5** (3); pp: 214-222.
- Fikire, Z., Tolosa. T., Nigussie, Z., Macias, C. and Kebede, N. (2012): Prevalence and characterization of hydatidosis in animals slaughtered at Addis Ababa abattoir, Ethiopia. *JPVB*, **4**: pp: 1-6.
- Flisser, A., Correa, D., Avilla, G. and Marvilla, P. (2005): Biology of *Taenia solium*, *Taenia saginata* and *Taenia saginata asiatica*. In: Murrell, K.D. (Ed.), WHO/FAO/OIE Guidelines for the surveillance, prevention, and control of taeniosis/cysticercosis. World Health Organization for Animal Health (OIE), Paris, pp: 1–9.
- Gemmell, M., Matyas, Z., Pawlowski, Z., Larralde, S., and Nelson, C. (1983): WHO Guidelines for Surveillance, Prevention and Control of Taeniasis /Cysticercosis. In 83: pp: 49-207
- Getachew, Y., Yalew, T and Tarekegn, T. (2017): Prevalence of *Cysticercus bovis* at Dessie municipal abattoir, North East Ethiopia. *Abyss. J. Sci. Technol. Vol. 2*: Pp: 25-29

- Gizaw, M., and Timotiwwos, W. (2022): Prevalence of *Cysticercus bovis* in cattle in case of Wolaita Sodo municipal Abattoir, Southern Ethiopia. *International Journal of Advanced Research in Biological Sciences* **9**: Issue 2. pp: 82-89
- Gracey, F. (1986): Collins SD. Meat Hygiene. 5th ed. Baillière Tindall, London, UK: pp: 413-420.
- Gracey, F. and Collins, S. (1992): Meat Hygiene. 5th ed. Baillière Tindall, 24–28 Oval Road,
- Gracey, F. and Thorntons, L. (1981): Meat Hygiene. 5th ed. London, Ballier Tindal. Pp: 24-28
- Gracey, J., Collins, S., and Huey, R. (2015): Meat Hygiene 11th ed. W.B. Saunders company Ltd, London, pp: 198–215.
- Grindle R. (2012): Economic loss resulting from *Bovine* cysticercosis with special reference to Botswana and Kenya. *Trop Anim Health Prod*; **10**: pp: 127-40.
- Grindle, R. (1978): Economic Losses Resulting From Bovine Cysticercosis with Reference to Botswana and Kenya, *Trop Anim Hlth Prod*, **10**, pp: 127-140
- Haben, F. and Isayas A. (2023): Prevalence and associated risk factors of *Cysticercosis bovis* in Bishoftu municipal abattoir, Central Ethiopia. *Environmental Health Insights* Vo. **17**: pp: 1–6.
- Hailu, D. (2005): Prevalence and risk factors for *T. saginata* Cysticercosis in three selected areas of eastern Shoa. MSc Thesis. Addis Ababa University, Faculty of Veterinary Medicine, Debrezeit, Ethiopia
- Hardy, F., Ibrahim, B., Morsy, T. and Ramadan, N. (1999): Human Taeniasis and Cysticercosis in Slaughtered Cattle; Buffalo and pigs in Egypt. *J. Egy Soci. Parasitol.* **29** (2), pp:34-39
- Harrison, L., Onyango-Abuje, J., A-Schuitto, E., and Parkhouse, R. (2001): Cysticercosis Diagnostic aspects in animals. In International workshops on Cysticercosis Pretoria South Africa, pp: 92-99.
- Harrison, L., Onyango-Auje, E., A-Schuitto, R., and Parkhouse, T (1997): Cysticercosis Diagnosis aspects in animals. In international workshop on, Cysticercosis, pritoria, South Africa, pp: 92-99.
- Harrison, L., and Sewell, M. (1991): The Zoonotic *Taeniae* of Africa. In: Parasitic Helminths and Zoonoses in Africa. London. Unwin Hyman. pp: 54-56.

- Hashemnia, M., Shahbazi, Y. and Safavi, E. (2015): Bovine cysticercosis with special attention to its prevalence, economic losses and food safety importance in Kermanshah, west of Iran. *J Food Qual Hazards Control*, 2, pp: 26–29.
- Hendrickx, E., Thomas, L., Dorny, P., Braae, U. and Devleess, B. (2019): Epidemiology of *Taenia saginata* taeniosis/cysticercosis: A systematic review of the distribution in West and Central Africa. *Parasites Vectors* **12**, pp: 324-329
- Hoberg, E. (2002): *Taenia* tapeworms: Their biology, evolution and socioeconomic significance. *Microbes Infect.* **4**; pp: 859–866.
- Hoberg, E. (2006): Phylogeny of *Taenia*: Species definitions and origins of human parasites. *Parasitol Int.* **55**; pp: 23–30.
- Hoberg, E., Jones, A., Rausch, R., Eom, K. and Gardner, S. (2000): A phylogenetic Hypothesis for species of the genus *Taenia* (Eucestoda: Taeniidae). *J. Parasitol.* **86**; pp: 89–98.
- HZARDO, (2023): Halaba Zone Agricultural and Rural Development Office annual Amharic report, Plan Commission department, Halaba kulito, pp: 1-12
- Ibrahim, N. and Zerihun, F. (2012): Prevalence of *Tania saginata* cysticercosis in Cattle Slaughtered at Addis Ababa Municipal Abattoir, Ethiopia. *Global Veterinaria*, **8**(5), pp: 467-471.
- Jansen, F., Dorny, P., Trevisan, C., Dermauw, V., Laranjo, M. and Allepuz, A. (2018): Economic impact of bovine cysticercosis and taeniosis caused by *Taenia saginata* in Belgium. *Parasites Vectors*, **11**, pp: 241-248
- Kassai, T. (1999): *Vet Helminthology*. 1th ed. New Delhi, Butter Worth. Heinemann. Pp: 42-37.
- Kassaw, M., Belay, W. and Tesfaye, W. (2017): Prevalence of *Cysticercus Bovis* in cattle slaughtered at Kombolcha ELFORA meat processing factory, northern Ethiopia. *Int. J. Curr. Res. Biol. Med.* **2** (2), pp: 1–6.
- Kebede, N. (2008): Cysticercosis of slaughtered cattle in northwestern Ethiopia. *Res Vet Sci* **85**, pp:522–526.

- Kebede, N., Tilahun, T., and Hailu, A. (2009): Current status of bovine cysticercosis of slaughtered cattle in Addis Ababa municipal abattoir, Ethiopia. *Tropical Animal Health and Production* **41**, pp: 291-294.
- Ketema, T., Getahun, K., and Bacha, K. (2009): Therapeutic efficacy of chloroquine for treatment of *Plasmodium vivax* malaria cases in Halaba district, South Ethiopia. *Parasites Vectors*. pp: 4: pp: 46-50
- Khaniki, G., Raei, M., Kia, E., Haghi, A. and Selseleh, M. (2009): Prevalence of bovine cysticercosis in slaughtered cattle in Iran. *Trop. Anim. Health Prod.*, **42**(2): pp: 141-143.
- Kifle, W. and Shiret, B. (2015): Prevalence and public health significance of cysticercus bovis in and around Debre Berhan city. *European J App Sci.*; **7**: pp: 199-208.
- Kumar, A. and Berhe, G. (2008): Occurrence of cysticercosis in cattle of parts of Tigray region of Ethiopia. *Haryana Vet.*, **47**, pp: 88-90
- Kumar, A. and Tadesse, G. (2011): Bovine cysticercosis in Ethiopia: a review. *Ethiop. Vet. J.*, **15**(1), pp: 15-35.
- Kyvsgaard, N and Murrell, K. (2005): Prevention of taeniosis and cysticercosis. In: Murrell, K.D. (Ed.), WHO/FAO/OIE Guidelines for the Surveillance, Prevention, and Control of Taeniosis/Cysticercosis. World Health Organization for Animal Health (OIE), Paris, pp: 57-72
- Laranjo-González, M., Devlees schauwer, B., Gabriël, S., Dorny, P. and Allepuz, A. (2016): Epidemiology, impact and control of bovine cysticercosis in Europe: a systematic review. *Parasit Vectors*, **9**; pp: 81-88
- Lawson, J. and Gemmell, M. (1985): The potential role of blowflies in the transmission of taeniid tapeworm eggs. *Parasitology* **91**, pp: 129–143
- Lielt, E., Desalew, T., Tsegabirhan, K., Teshale, S. and Yohannes, H. (2015): Prevalence and public health significance of bovine cysticercosis at Elfora abattoir, Bishoftu, Ethiopia, *journal of public healthand epidemiology*. **7**: pp: 32-40.
- Lonc, E. (1980): The possible role of the soil fauna in the epizootiology of cysticercosis in cattle. I. Earthworms—the biotic factor in a transmission of *Taenia saginata* eggs. *Angew Parasitology* **21**, pp: 133–139.

- Lopes, W., Cruz, B., Soares, V.E., Nunes, J., Teixeira, W. and Maciel, W. (2014): Historic of therapeutic efficacy of albendazole sulphoxide administered in different routes, dosages and treatment schemes, against *Taenia saginata* cysticercus in cattle experimentally infected. *Exp Parasitol*, **137**; pp: 14–20.
- Maeda, G., Kyvsgaard, N., Nansen, C. and Bogh, H. (1996): Distribution of *Taenia saginata* Cyst by Muscle group in Naturally Infected Cattle in Tanzania. *Prev.Vet.Med.* **28**(2), pp: 81-89.
- Mann, I. (1984): Environmental Hygienic & Sanitary Based on Concept of Primary Health as a tool for Surveillance, Prevention and Control of Taeniasis /Cystercosis. *Current Publication in HealthResearch Tropics*, **36**; pp:127-140.
- Markell, E., John, D. and Krotoski, W., (1999): Medical parasitology 8th edition, pp: 257-269.
- Megersa, B., Tesfaye, E., Regassa, A., Abebe, R. and 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: pp: 257-262.
- Meiry, M., Brenner, G., Markovits, A., Klement, E., (2013): A change in the epidemiology of bovine cysticercosis in Israel between 1973 and 2008 due to import of live cattle. *Journal of Trans boundary and Emerging Disieases*, **60**; pp: 298-302.
- Mekonnen, K. (2017): Study on prevalence of *Cysticercus bovis* in cattle at municipal abattoir of Kofale district, west Arsi zone, Oromia regional state, Ethiopia. *J. Biol. Agricult. Healthcare*, **7** (17), pp: 222–228.
- Mesfin, B. and Nuraddis, I. (2012): Prevalence of *Cysticercus Bovis* in Hawassa Municipal abattoir and its Public Health Implication, *American-Eurasian J. Sci. Res*: pp: 238-245.
- Minozzo, J, Gusso, R., De Castro, E., Lago, O. and Soccoi, V. (2002): Experimental Bovine Infection with *Taenia saginata* Eggs: Recovery Rates and Cysticerci Location. *Braz.arch. biol. technol.* **45**, pp: 4-10
- MOA, (2015): Meat inspection regulation. Negarit Gazeta, Addis Ababa, Ethiopia, P: 428.

- Murrell, K. (2005): Epidemiology of taeniosis and cysticercosis. In: Murrell, K.D. (Ed.) WHO/FAO/OIE Guidelines for the surveillance, prevention, and control of taeniosis/cysticercosis. WHO/FAO/OIE, pp: 27– 43.
- Netsanet, B., Yesuf Y., Abrha, B. and Lewtnesh B. (2020): Prevalence and public health importance of bovine cysticercosis in and around Dessie, Amhara region, North East Ethiopia. *Nigerian J. Anim. Sci.* Vol, **22** (2): pp: 173-185.
- Nicholson, M. and Butterworth, M.(1986): A guide to conditionscoring of zebu cattle. International Livestock Centre for Africa, Addis Ababa, Ethiopia
- Nigatu, K. (2004): *Cystisercus bovis* development and evaluation of serological tests and prevalence at Addis Ababa abattoir. Msc Thesis, Faculty of Veterinary Medicine. Addis Ababa University, Debre-Zeit, pp: 1-61
- Nunes, C., Lima, L., Manoel, C., Pereira, R., Nakano, M. and Garcia, J. (2003): *Taenia saginata*: Polymerase chain reaction for taeniasis diagnosis in human fecalsamples. *Exp Parasitol.* **104**, pp: 67-9.
- Nuraddis, I. (2012): Prevalence of *Cysticercus bovis* in Hawassa municipal abattoir and its Public health implication. *American-Eurasian Journal of Scientific Research*, **7** (6): pp: 238-245
- Nuraddis, I. and Frew, Z. (2012): Prevalence of *Tania Saginata* Cysticercosis in Cattle Slaughtered in Addis Ababa municipal abattoir Ethiopia, *Global Veterinarian*, **8**(5): pp: 467-471.
- OIE (2000): Manual of Standards for Diagnostic Tests and Vaccines. Cysticercosis. Pp: 423-428.
- OIE, (2008): OIE Terrestrial Manual Chapter 2.9.5.
- Okello, A. and Thomas, L. (2017): Human taeniasis: Current insights into prevention and management strategies in endemic countries. *Risk Manag Health Policy.* **10**, pp: 107–16.
- OnyangAbuje, J., Hughes, G., Opicha, M., Niginyi, K., Rugutt, M., and Harrison, L. (1996): Diagnosis of *Taenia saginata* Cystcercosis in Kenian Cattle by Antibody and Antigen ELISA *Vet.Parasitol*, **61** (3), pp: 221-230.
- Opara, M., Ukpong, U., Okoli, I., and Anosike, J. (2006): Cysticercosis of slaughter cattle in southeastern Nigeria. *Ann N Y Acad Sci.* 1081, pp: 339–346

- Oryan, A. Gaur, N. Moghadar, N. and Delavar, N. (1998): Clinico-Pathological Studies in Cattle Experimentally Infected with *T.saginata* eggs. *J.Est. Afr. Vet. Assoc.* **69** (4), pp: 156-162.
- Pawlowski, Z. Allan, J. and Meinardi, H. (2005): Control measures for taeniosis and cysticercosis World Health Organization for Animal Health (OIE), Paris, pp: 73–9.
- Pawlowski, Z. (1996): Helmenthic zoonosis affecting humans in Africa. *Vet. Medicine, impacts on human health and nutrition in Africa, Proceedings of an international conference Lindberg*, pp: 50-71
- Rabi’u, B., and Jegede, O. (2010): Incidence of *bovine cysticercosis* in Kano state, north western Nigeria. *Bayero Journal of Pure and Applied Sciences*, **3**(1), pp: 100–103.
- Radostits, O., Blood, D., Gay, C., Hinch cliff, K., and Constable, P. (2007): *Veterinary Medicine. Text book of the disease of cattle, sheep, goat, pig and horses.* 10th ed. Saunders. Philadelphia, pp: 1581-1583.
- Regassa, A., Abunna, A., Mulugeta and Megersa, B. (2009): Major Metacestodes in cattle slaughtered at Wolaita Soddo Municipal abattoir, Southern Ethiopia: Prevalence, cyst viability, organ distribution and socio economic implications. *Trop Anim Health Produ.* **41**: pp: 1495-1502.
- Rodriguez-Hidalgo, R., Benitez, W., Dorny, S., Geysen, D. and Ron-Roman, J. (2003): Taeniosis-cysticercosis in Man and Animals in the Sierra of Northern Ecuador. *Vet Parasitol.* **118**: pp: 51-60.
- Samatar, A. (2021): Study on Prevalence of Bovine Cysticercosis and Human Taeniasis in Jigjiga Town, Somali Region, Eastern Ethiopia. *Global Journal of Medical Research: G Veterinary Science and Veterinary Medicine Volume*, **21**(1); pp: 21-29.
- Samuel, B and Berihun, A. (2014): Prevalence of *Cysticercus bovis* in Cattle slaughtered at Shire municipal abattoir. *J Veterinar Sci Technolo*, **5**(4): pp: 19-26
- Sanchez, A. and Fairfield, T. (2003): Using electronic technology for *Taenia solium* education: Educating the educators. *Acta Trop.* **87**, pp: 165–170.
- Sanpool, O., Rodpai, R., Intapan, P. Sadaow, L., Thanchomn, T. and Laymanivong, S. (2017): Genetic diversity of *Taenia saginata* (Cestoda: Cyclophyllidea) from Lao People’s Democratic Republic and northeastern Thailand based on mitochondrial DNA. *Parasites Vectors* **10**, pp: 141-150

- Sau'rez, H. and Santizo, R. (2005): Epidemiology of the *Taenia saginata* complex and *C. bovis* in Ciego de Avila province of Cuba. *Rev Pathol Trop*; **34**: pp: 43-52.
- Scandrett, B., Parker, L. Forbes, A. Gajadhar, P. Weikagul and D. Haines, (2009): Distribution of *Taenia Saginata* Cysticerci in tissues of experimentally infected cattle. *Veterinary Parasitology*, **164**: pp: 223-231.
- Schantz, P. (2002): *Taenia solium* cysticercosis. An overview of global distribution and transmission in *T. solium* from basic to clinical science pp: 63-74.
- Solomon. M. (2023): Prevalence of Bovine *Cysticercosis*, Human Taeniasis and Associated Risk Factors in Selected Towns of Silte Zone, Southern Ethiopia. It is made available under a *CC-BY 4.0 International license*, pp: 1-33
- Solusby, E. (1982): Helminths, Arthropods and Protozoa of Domestic Animals. 7thed. Bailliere Tindall, London. Lead and Febiger. Philadelphia, Philadelphia, pp:107-111
- Steinmann, P., Rg Utzinger, J., Jiang, J., Chen, J. and Hattendorf, J. (2011): Efficacy of Single-Dose and Triple-Dose Albendazole and Mebendazole against Soil Transmitted Helminths and *Taenia* spp.: A Randomized Controlled Trial. *PLoS One* 6, e 25003
- Symth, J. (1994): Introduction to Animal Parasitology. 3rd ed. Hodder and Stoughton: London pp: 259-273.
- Taylor, M., Coop R. and wall, R. (2007): Veterinary Parasitology. 3rd ed. USA: Black well, Publisher. pp: 121-123.
- Tegegne, A., Hiko, A. and Elemo, K. (2018): Bovine cysticercosis and humantaeniasis: Animal–human health and economic approach with treatment trends in Kombolcha Town, Wollo, Ethiopia. *International Journal One Health*, **4**: pp: 15-21
- Teka, G. (1997): Food Hygiene Principles and Food Borne Disease Control with Special Reference to Ethiopia. 1sted. Faculty of Medicine Department of Community Health Addis Ababa University, pp: 40–62.
- Teklemariam, A. and Debash, W. (2015): Prevalence of *Taenia saginata*/cysticercosis and community knowledge about zoonotic cestodes in and around Batu, Ethiopia. *J Vet Sci Technol*; **6**: pp:273-279

- Tembo, A. (2001): Epidemiology of *Taenia saginata*, Taeniasis/ Cysticercosis in Three Selected Agro-Climatic Zones. Faculty of Veterinary Medicine, Free University of Berlin, Berlin, MSc Thesis
- Tesfay, H and Assefa, A. (2012): Cysticercosisbovis in Eastern Tigray, Northern Ethiopia. *In J Innov Sci Res*.**10**: pp:2351-8014.
- Tesfaye, D., Fekede, D., Worku, T., Regassa, A. and Fekadu, A. (2013): Perception of the public on the common zoonotic diseases in Jimma, Southwestern Ethiopia. *Int J Med*. **5**, pp:279–285.
- Tesfaye, D., Sadado, T., and Demissie, T. (2012): Public Health and Economic Significance of Bovine Cysticercosisin Wolaita Soddo, Southern Ethiopia. *Global Veterinaria*, **9**(5), pp: 557-563.
- Tewodros, A, Annania, T, Sara, T. (2015): Study on the prevalence of *Cysticercus bovis* in Kombolcha Elfora, North-Eastern Ethiopia, faculty of veterinary medicine, and university of Gondar. *Eur J Appl Sci*; **7**: pp:152-157
- Tewodros, A. and Alemneh, T. (2017): Mini-Review on Bovine Cysticercosis. *Gavin J Arch Vet Sci Technol*; *VST 110 DOI:10.29011/AVST-110/100010*
- Thrusfield, M. (2007): Veterinary epidemiology, 3rd edition Black well science tropics, Ltd, Oxford, England, pp: 332.
- Tolosa, T., Tigre, W., Teka, G and Dorny, P. (2009): Prevalence of bovine cysticercosis and hydatidosis in Jimma municipal abattoir, South West Ethiopia. *Onderstepoort Journal of Vet Research*, **76**, pp:323-326.
- Torgerson, P. (2013): One world health: Socioeconomic burden and parasitic disease control priorities. *Vet Parasitol*. **195**; pp: 223-232
- Urquhart, G., Armour, J., Duncan, J., Dunn, F. and Jennings, H. (2013): Veterinary Parasitology. 8th edn. Black Well Science, London, pp: 120-137.
- Utulas, M., Esatgil and Tuzer. (2007): Prevalence of hydatidosis in slaughtered animals in Thrace, Turkey Parasitology Dergisit, **31**: pp: 41-45.

- Vargas-Calla, A., Gomez-Puerta, L., Pajuelo, M., Garcia, H. and Gonzalez, A. (2018): Molecular detection of taeniid eggs in beetles collected in an area endemic for *Taenia solium*. *Am J Trop Med Hyg.* **99**; pp:1198-1200.
- Wabi, E and Girmay, H. (2019): Study on Prevalence of Bovine Cysticercosis and Public Health Importance of Taeniosis at the Nekemte Municipal Abattoir, Nekemte, Western Oromia. Volume 9(1) DOI: 10.19080/JDVS .09.555754. ISSN: pp: 2573-2196.
- Wanzala, W., Onyango-Abuje, E. Kang, K. Zessin, N. Kyule, M. Bauman, H. Ochanda, L. and Harrison, P. (2003): Analysis of Post-Mortem Diagnosis of Bovine Cysticercosis in Kenyan Cattle, Onderstepoort. *J. Veterinary Research*, **1**: pp: 28-31.
- WHO and FAO, (2016): Veterinary public health. *Journal on Zoonoses and veterinary public health*.
- WHO, (1995): Model prescribing information; Drugs used in Parasitic Disease. 2nded. Geneva, pp: 91-98. .
- Wondimagegne, K. and Belete, S. (2015): Prevalence and public health significance of cysticercus bovis in and around debreberhan City, *European Journal of Applied Science* **7** (5): pp: 199-208.
- Yimer, A. and Gebrmedehan, B. (2019): Bovine Cysticercosis and Hospital Based Retrospective Survey of Human Taeniasis in and Around Debre Brihan City, Central Ethiopia. *Biol Med (Aligarh)* **11**:455. doi:10.35248/0974-8369.19.11.455.
- Yoder, D., Eblell, E., Hancock, D. and Combs, B. (1994): Public Veterinary Medicine: Food Safety and Handling, Epidemiological Findings from an Out Break of Cysticercosis in Feed lot Cattle. *J. A.V.M.A.* **205** (1), pp: 75-86.
- Zdolec, N., Vujević, I., Dobranić, V., Juras, M., Grgurević, N., Ardalić D, (2012): Prevalence of *Cysticercus bovis* in slaughtered cattle determined by traditional meat inspection in Croatian abattoir from 2005 to 2010. *Helminthology*, **49**; pp: 229-232.

8. ANNEX

Annex 1: Questionnaire Survey Format Sheet

- ❖ Owners House Location, Marital States, Educational Level, Sex, Age, Occupation and Farming Type

1. Personal Address and Information

Name of Respondent _____ Age _____ sex _____ religion _____
Occupation _____ Zone _____ Wereda _____ kebele _____

1. Household location? **A.** Rural **B.** Urban **C.** Peri-urban
2. Marital States? **A.** Married **B.** Single
3. Number of people in household? **A.** Males__**B.** Females__ **C.** Children <15yrs **D.** Self
4. Educational Level? **A.** Illiterate **B.** Mid- level **C.** Higher level
5. Major Farming activity? **A.** Livestock Production **B.** Crop Production **C.** Mixed type
6. How do you manage your cattle? **A.** In the home **B.** Community grazed
C. Stall-feed **D.** Both in the home and grazing land

2. Information regarding knowledge of *Cystisercus bovis* / Taeniasis

1. Do you know human taeniasis or 'Koso'? **A.** Yes **B.** No
2. Have you suffered from taeniasis in your past life times? **A.** Yes **B.** No
3. In question number 2 if your answer is yes how many times you suffered in your life time?
A. One times **B.** Two times **C.** Three times **D.** More than three
4. Do you know the symptoms of taeniasis? **A.** Yes **B.** No

5. Do you think that tape worm diseases are treatable in humans? A. Yes B. No

6. Have you ever used taenicidal drug? A. Yes B. No

7. In question number 6 if your answer is yes what type of drug you used?

A. Modern B. Traditional

8. Do you have latrine facility at your home? A. Yes B. No

9. In question number 8 if your answer is no where do you defecate? A. On the field

B. Around the bush C. On agricultural land D. Every where

10. Which type of meat you prefer for conception?

A. Raw B. Well Cooked

12. Do you know raw beef conception has health risks to humans? A. Yes B. No

3. Information regarding zoonotic disease transmission

1. Have you ever heard about zoonotic disease? A. Yes B. No

2. In question number 1 if your answer is “Yes” from whom you heard? A. Friend

B. Health workers/Veterinarians C. Media D. Family member/People from the village

3. Do you know how can disease transmit from animals to human? A. Yes B. No

4. Do you know how cattle are infected by *C.bovis*? A. Yes B. No

5. Do you know open defecation of infected person can transmit the infection to cattle?

A. Yes B. No

6. Do you know tape worm can be transmitted from animal to human by consumption of raw/undercooked meat? A. Yes B. No

7. Do you think tapeworm infections can be prevented? A. Yes B. No

Annex 2: Abattoir Report data collection format sheet

No	Origin of animal	BCS of animal	Sex of animal	Age of animal	Breed of animal	Affected organ	States of result	No. of cyst count
1								
2								
3								
4								
5								
6								
7								

Annex 3: Pharmaceutical retrospective data collection format sheet

List of drug	Year, total dose, and total price					
	Dose in 2019	Dose in 2020	Dose in 2021	Dose in 2022	Dose in 2023	Total dose and total price
Praziquantel						
Niclosamide						
Albendazol Tablet						
Albendazol suspension						
Total cost and dose						

Annex 4: Retrospective Health institutions data collection format sheet

No	Name of patient	Sex		Age	Year	Stool result	
		M	F			Positives	Negative
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

Annex 5: Description of body condition scores

Score	Condition	Feature
1	P ⁻	Marked emaciation (animal condemned at ante mortem examination)
2	P	Transverse process project prominently, neural appear sharply
3	P ⁺	Individual dorsal spines are pointed to the touch, hip pins, tail, head ribs are prominent. Transverse process visible ,usually common
4	M ⁻	Ribs, hip and spins clearly visible muscle mass between hook spines slightly concave and slightly more fleshy
5	M	Ribs usually visible little fat cover dorsal spines barely visible
6	M ⁺	All smooth and well covered dorsal spines cannot be seen ,but are easily felt
7	G ⁻	All smooth and well covered, but fat deposition are not marked, dorsal spins can be felt with firm pressure but rounded rather than sharp
8	G	Fat cover in critical area can be seen and felt transverse process cannot be seen
9	G ⁺	Heavy deposited of fat clearly visible on tail, head, brisket and dorsal spines, ribs, hook and fully covered and cannot be felt even with firm pressure

Source: Nicholson and Butterworth (1986).

Note: body condition scores;

- 1, 2 and 3 are poor body condition
- 4, 5 and 6 are medium body condition
- 7, 8 and 9 are good body condition

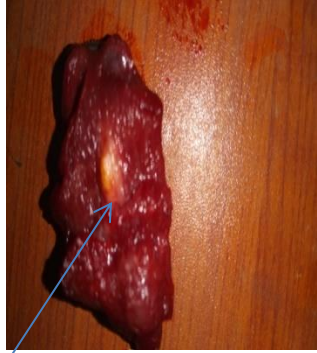
Annex 6: Equipment and chemical (reagent) used in the laboratory for cyst viability test

Ice box, Glove, Alcohol, Distilled water, Beaker (500ml), Graduated cylinder(100ml), Scalpel blade, Cover slip, Microscopic slide, Disposable syringe(10ml), Scissors, 70% saline solution, 30% ox bile, electric thermostatic incubator and microscope.

Annex 7: A few Pictures taken during sample collection in the abattoir and in the laboratory



Crushed calcified cyst
from tongue



Non-viable cyst from
heart



Calcified cyst from
liver



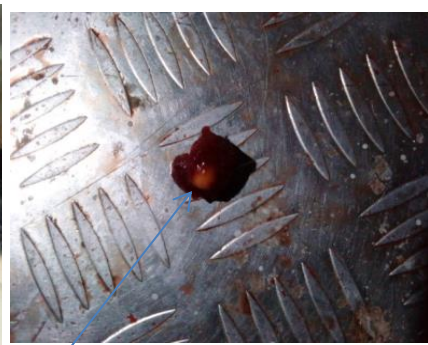
Calcified cyst from
shoulder muscle



Calcified cyst from tongue



Viable cyst from tongue



Non-viable cyst from M. muscle



Cyst before incubation



Thermostatic incubator

