

# Prevalence and economic importance of *Coenurus Cerebralis* in sheep and goats in and around “Legahida” district of bale zone, south eastern Ethiopia

Johar Aliye<sup>1</sup> · Feyissa Begna Deressa<sup>1</sup>

Received: 21 July 2016 / Accepted: 10 January 2017 / Published online: 6 February 2017  
© Springer-Verlag London 2017

**Abstract** Coenurosis is a disease caused by *Coenurus cerebralis*, the larval stage of *Taenia multiceps*, particularly affecting sheep and goats. *T. serialis* and *T. brauni* could also cause coenurosis. The final hosts are domestic and wild canidae. Cross sectional study was conducted from November 2014 to March 2015 to estimate the prevalence and associated risk factors of *Coenurus cerebralis* in both sheep and goats in Legahida backyard slabs. The estimation of its economic burden and assessment of knowledge, attitude, and practices (KAP) of the pastoral and agro-pastoral communities were also performed for which questionnaire survey was used. A total of 412 sheep and goats were examined for *C. cerebralis* cysts. From this, 52 (12.6%) (95% CI 9.4, 15.8) of them were positive for *T. multiceps* cyst/s in one or different parts of the brain. The cyst numbers in the brains varied from 1 to 5. The prevalence in sheep is statistically significantly different compared to that in the goats ( $P = 0.003$ ). The prevalence according to age groups (categorized as less than 2 years, 2 to 4 years, and older than 4 years) was found statistically highly significantly different ( $P = 0.000$ ). Cysts were more recovered from the cerebrum (88.4%), followed by cerebellum (10.5%), and median fissure (1.16%). Non parametric correlation analysis between pathognomonic clinical sign and cyst recovery from the brain is very high correlation coefficient ( $CC = 0.956$ ). Clinical disease and cyst location are also highly positively correlated with the coefficient of ( $CC = 0.826$ ) left hemisphere and 0.802 right hemisphere. The size of the cyst is positively correlated with clinical disease ( $CC = 0.797$ ). The questionnaire data revealed that

(72%) of the respondents own dogs, and deworming practice is very small (92% are not practicing). 47.4% of total respondents complained dog feces as the cause of the disease. The monetary losses from mortality during last year was estimated to be 398,250 ETB (19,432.61US\$) whereas average monetary losses from esthetic value of 50 clinically diseased animals was about 17,500 ETB; wage loss from treatment seeking, loss from treatment costs, and indirect losses from poor carcass weight were 1250, 3120, and 65,318.4 birr, respectively. These monetary loss totals to the sum of 485,438.4 ETB (\$23679.92) per year at “Legahida” district. Thus, the study revealed that *C. cerebralis* is economically important disease of sheep and goats in and around Legahida district, and effective control measures must be taken.

**Keywords** C. Cerebralis · Cyst · Sheep · Goats · Prevalence · Pastoral · Agro-pastoral · Postmortem

## Introduction

Livestock in developing countries plays a crucial role in improving food security, generating cash income, and are an asset. The total livestock population in Ethiopia according to 2014 estimation was 56.71 million cattle, 29.33 million sheep, and 29.11 million goats (CSA 2015), which places Ethiopia first in Africa and ninth in the world in terms of total stock population. Small ruminants are integral part of livestock keeping in Sub-Saharan Africa (SSA) that are mainly kept for immediate cash sources, milk, meat, wool, manure, and saving or risk distribution (Kosgey 2004). In addition, they are attractive for their easy adaptability to broad range of environment, short generation cycles, and high production rate (Adane et al. 2015). While Ethiopia’s annual exports of cattle and sheep meat were valued at USD 79.13 million in 2012 (ECRA 2012), Ethiopia fails to

✉ Feyissa Begna Deressa  
fey\_abe2009@yahoo.com

<sup>1</sup> School of Veterinary Medicine, College of Agriculture and Veterinary Medicine, Jimma University, P.O. Box 307, Jimma, Ethiopia

optimally utilize this resource as the sector is suffering from lower productivity. Sheep and goat production in Ethiopia is mainly carried out by smallholder farmers and pastoralists. This succumb the sector to poor reproductive performance, uneasy control of diseases, and poor management (Brook 1983).

Among the many diseases that make small ruminants economically poor performers, parasitism is in the common. One of such parasitism is Coenurosis caused by *Coenurus cerebralis*, the larval stage of *Taenia multiceps*, mainly affecting sheep and goats (Oge et al. 2012). The larval forms of *T. serialis* and *T. brauni* can also cause coenurosis less commonly. The clinical signs of the disease develop when the CNS of the sheep/goat is invaded by *Coenurus cerebralis* cyst (Edwards and Herbert 1982; Avcioglu et al. 2012). The adult tape worm, *Taenia multiceps*, is found in the small intestine of the dogs and wild canides. The larval form may rarely infect man on accidental ingestion of tape worm's egg in the feces of dogs and causes neurosis. It is worldwide in distribution but is most common in the developing countries of Africa and Asia where sheep and goat rearing is a common source of income (Nourani and Kheirabadi 2009).

Different scholars have reported that Coenurosis is the problem of domestic small ruminants. Examples are Achenef et al. (1999) who reported 19.1% in Ethiopian high land sheep, Neni et al. (Nenni et al. 2012) reported a prevalence of 11.5% in sheep and goat from Yabello District, Borana Zone, southern Ethiopia, and Adane et al. (2015) reported an overall prevalence of 3.78% from Hashim Export Abattoir, Debre Zeit, Ethiopia. In Turkey, Uslu and Guclu (2007) reported an overall prevalence of 16.34% from abattoir survey and, in addition, Gicik et al. (2007) reported a prevalence of 15.5% in sheep in Kars Province, Turkey. Nenni et al. (2012) estimated a preliminary economic loss from this disease to estimate its burden to the small ruminant producing farmers in particular and the country at large. Coenurosis being a significant disease from economic point of view in small ruminants, it has never been studied in large scale in Ethiopia and “Lagahida” district in particular. The data on prevalence estimate of Coenurosis and the risk factor contributing to its distribution at Lagahida district is lacking. In addition, peoples' knowledge and attitude on Coenurosis has never been evaluated at Lagahida district. We believe also that a preliminary Coenurosis economic burden estimation is an important informative to livestock disease prevention and eradication police makers. Therefore, the objectives of this study were to address the following:

- To determine the current prevalence of *Coenurus cerebralis* in both sheep and goats and associated risk factors for its occurrence at *Legahida* district
- To assess knowledge, attitude, and practices of the pastoral and agro-pastoral communities with respect to *Coenurus cerebralis*
- To estimate economic losses due to *Coenurus cerebralis*

## Materials and methods

### Study area

The study was conducted in Oromia Regional State, Bale Zone in and around Legahida district, which is located 681 Kms East of Addis Ababa at altitude of 1200–1800 m.a.s.l. The area is bordering with East Arsi and West Hararghe to North, Sawena and Gololcha to South, Gololcha to the west, and Somali to the East, and East Hararghe to Northeast (Fig. 1). Grazing is predominantly communal with emerging privatization of crop and “*Kalo*” locally (grazinglands). The average annual temperature ranges between 25 and 30 °C, and the area has two rain seasons with the main rainy season from March to May, and the small rainy season from September to November, with an average annual rainfall varying from 900 to 1200 mm per annum. There are eight butchers (backyard slabs) in the town, and these are used to slaughter two heads of animals each day on average.

### Study population

The target population was all sheep and goats of the study area. The study/accessible populations were sheep and goats presented to backyard slaughter slab. Animal slaughtered in *Legahida* slaughter slabs (restaurant) were sheep and goats from different Peasant Associations (PAs) of *Legahida* district namely Legahida town (Beltu), Cefa, Hidadunda, maedina, Luku, and Gororaya.

### Study design and sample size determination

Cross-sectional study was implemented along with convenience sampling methods of the study animals. Size of the study animals was determined based on internationally set standard formula in (Thrusfield 2005). There was no previously documented prevalence of coenurosis in the study area. The confidence and precision levels were set to 95 and 5%, respectively, and conservative expected prevalence of 50% was used. Hence, the minimum sample size required was 384.

### Sample collection methodology

#### *Ante-mortem examinations*

Before post-mortem examination, the animals to be slaughtered were subjected for clinical examination. During the 5 months research period, samples were collected three times per week to obtain heads of animal slaughtered at slabs. On every visit to the restaurants, 6–8 heads of small ruminants were collected and examined for brain cyst; one head from the other was selected by lottery system. The related risk factors such as age, sex, breed, and origin were also recorded in

## Oromia Region



**Fig. 1** Oromia regional Map showing research area. Source: <http://www.ocha-eth.org/Maps/downloadables/OROMIYA.pdf>

specially designed checklist sheet as explanatory variables. The position of the head (tilting, lifting, and lowering) and the gait (tendency to fall, roll, or circle towards the right or left side) were observed and recorded as clinically diseased. The age of the animals were estimated based on stage of dentitions as described by NARI (2003).

#### Post-mortem examinations

The skull removal and dissection were conducted according to the method described by Gicik et al. (2007), which states that the skull should be removed by ventral disarticulation of the atlanto-occipital joint and after removal of the skin; the area just caudal to the frontal bone should be cut cross-sectional, followed by two parallel cuts on the parietal bone. The bones were removed using a chisel and hammer, and the meninges were incised with a scalpel blade, so exposing the brain. A detailed examination was made for the presence of cysts in different parts of the brain macroscopically by visual inspection, palpation, and where necessary one or more incisions were made in order to inspect small *T. multiceps*'s cysts. The examination of spinal cord was not successful because owners denied providing as it is used for food with the remnant of meat on the spines. The location, number, and size of the cysts were recorded. The size of the cyst was measured using normal ruler. In addition to post-mortem examination, the pastoral and agro-pastoral households possessing sheep and goats were questioned using pre-tested semi-structured

questionnaire in the study sites to assess their knowledge, practice, and attitude as far as coenurosis is concerned.

#### Estimation of economic losses

##### Direct loss

Economic data were collected using semi-structured questionnaire. The data included like cost of sheep and goats and number of dead animal due to coenurosis during last year and average lost market price due to the disease. The treatment cost of the diseased sheep and goats and wage loss due to seeking treatment were included in direct economic assessment.

##### Indirect loss

A 5% carcass weight loss estimate was considered from the recommendation of Torgerson et al. (2001) who used it to calculate the economic impact of hydatid cyst in livestock. So, the annual estimated economic loss due to carcass weight reduction of *T. Multiceps* cyst was calculated as follows:  $IL = 5\% \times NAS \times CPB \times 15 \text{ kg}$ , where IL is indirect loss, 5% is estimate carcass weight loss due to *T. Multiceps* cyst, NAS is average number of animal slaughtered in slaughter slab annually, PH is prevalence of *Coenurosis*, CPB is current average price of 1 kg of sheep and goat meat, and 15 kg is average carcass weight of sheep and goats.

Total economic loss was then calculated as follows:

$$\text{Total economic loss} = L + IL$$

### Statistical analysis

The explanatory variables are age, sex, breed, species, origin, cyst size, and cyst number. The collected data were then entered into Microsoft excel spread sheet for windows and analyzed using SPSS version 20 software program. The overall prevalence was calculated as the number of sample positive was divided by the total number of sample examined and multiplied by 100. Association between the risk factors and the response variables (cyst harboring) was assessed using Multivariable Logistic regression test. Odds ratio was also calculated to measure the strength of association and observe the direction of the effect. For all analysis, a *P* value less than 0.05 were taken as statistically significant. The nonparametric correlation was also analyzed to evaluate the correlation between cyst presence in the brain and clinical sign observation, size of cyst and clinical sign observation, and location of cyst and clinical disease observation. Total economic loss was calculated as DL + IL.

### Results

From the total of 412 sheep and goats' heads examined, 52 (12.6%) (CI 9.4, 15.8) of them were found with *T. multiceps*'s cyst (s) in one or different parts of the brain. Clinical symptoms of coenurosis were seen in 50 (9.95%) of the total heads examined, and 2(0.55%) of 362 apparently healthy examined animals proved to be infested with *M. multiceps*'s cyst (Table 1). Prevalence of coenurosis was also estimated based on age, sex, origin, and species of the study animals. The prevalence in sheep and goats were 20.7 and 9.6%, respectively. Sheep had 2.23 times more odds of harboring the Cysts. The prevalence according to the age of animals were 31% in less than 2 years, 12.5% in 2 to 4 years, and 5.7% in older than 4 years. The odds of cyst harboring for the young (<2 years) is 6.74 times more likely compared to older age group (>4 years) while that of adult compared to same group is 2.33 (Table 1).

A total of 86 cysts were recovered from infected heads. The cyst numbers in the brains varied from 1 to 5. The results indicated that animals 25, 16, 8, 2, and 1 were infected to 1, 2, 3, 4 and 5 cyst(s), respectively (Table 5).

### Location and morphological description of *T. multiceps*'s cyst

Grossly, the cysts were round or oval, large and bladder like, and were found in the different parts of the brain. They measured approximately 0.8–6.5 cm in diameter and were filled with large amount of fluid. In addition, they contained numerous macroscopic invaginated scolices. Microscopically, the scolices showed four cup-shaped suckers and a rostellum armed with typical taeniid hooks arranged in double rows (Annex- 1). One or more cysts were found in different parts of the brain. In line with their location 76 (88.4%), 1 (1.16%), and 9 (10.5%) cysts were found in cerebrum, median fissure, and cerebellum, respectively, as shown in Table 2.

### Presentation of questionnaire data results

The post mortem (PM) findings were substantiated with the questionnaire survey of the sheep and goat owners in order to draw conclusion on the economic impact of coenurosis. Fifty Households (HHS) were interviewed, comprising 45 (90%) males and 5 (10%) females, of age ranging from 20 to 70 years with an average of 35 years. The educational status of respondents comprises 26% literate and 74% illiterate. Of the interviewed respondents, 100% expressed that they use communal grazing lands. The farming systems within the study settings comprise 62 and 38%, pastoral and agro-pastoral, respectively. Of the total interviewed respondents, 97.5 and 98.8% of them own sheep and goats, respectively. The flock size of goats and sheep ranges from (2–91) to (0–73) per house hold, respectively. All the respondents knew that *C. cerebralis* affects both sheep and goats.

The assessment of the death incidence over the last year revealed that a total of 590 (390 and 200) heads of sheep and goats died respectively. The average death was 4 and 2 heads of sheep and goats per HHS, respectively. All of the respondents explained that they send their “*Dhibliisa*” (coenurosis)

**Table 1** Final multivariable logistic regression model output of factors associated with *Taenia multiceps*' cysts recovery from sheep and goats brain (*n* = 412) from Lagahida, Ethiopia

Explanatory variables	No. of sheep and goat	% positive	Odds ratio	95% CI lower upper	Wald <i>P</i> value	–2Log L <i>P</i> value		
Age class	<2 years	19/61	31.0	6.72	2.81	16.10	0.000	0.000
	2–4 years	24/194	12.4	2.33	1.05	5.20	0.038	
	>4 years	9/157	5.7	1.00	Ref	Ref		
Species	Sheep	23/111	20.7	2.23	1.14	3.97	0.017	0.003
	Goat	29/301	9.63	1.00	Ref	Ref		

**Table 2** Location of *Taenia multiceps* cyst in the brain parts, their number, and their size

Cyst location in brain		No of cysts per total number		Percentage	
Cerebrum	RH	76/86	35/76	88.4	46
	LH		41/76	54	
Median fissure		1/86			1.16
Cerebellum		9/86			10.5
Diameter in cm		Number of cyst(s)		Percentage	
<1		10			11.6
1–2		9			10.46
2–3		25			29.1
3–4		20			23.3
4–5		11			12.8
5–6		8			9.3
>6		3			3.5
Total		86			100

infected sheep/goat to the market for local butchers or home consumption. The practice of the community with regard to the treatment of infected animals revealed that 26.41 and 23.62% give acaricide like Amitraz in liquid form which is 12.5% without diluting into water (they call Amitraz as “*dhibkaa*” locally). This assessment revealed that 18% of the respondent management, the head from pathognomonic sign of *Coenurosis*, is by burying, 12% by burning, and 70% by offering to dogs (Table 3). 47.4% of total respondents complained that dog feces as the cause of the disease, while the rest of respondents complained that urine of dogs, urine of infected animals, thirst, polluted water by urine of dog and monkeys, and change of environment as causes of the disease. Knowledge of prevention mechanism was asked, and 18 and 15.5% complained burying infected heads and reducing dog population, respectively.

The interviewee’s response on the dog ownership and past history of coenurosis revealed that, 70% owned dog, and their domestic shoats were suffered from the disease. Only 1.96% of respondents practiced deworming of their dogs. Practice on dog feces was also assessed, and it was revealed that 16, 68, and 16% bury, leave it on the open field, and collect on “*Kosii qe’ee*” which means garden wastes, respectively (Table 4).

In addition to dog population, 100% of the respondents complained “Gedala” (fox) was the primary predators of small

ruminants. The other risk factor considered for coenurosis occurrence is a place where lambs or kids kept before weaning age. To this question, 100% of respondents replied that they keep their kids and lambs in homestead or village; with 67.3 and 32.7% of them complained soil licking (village grazing) and hand feeding habits of kids/lambs, respectively. Age category sets of sheep and goats bought for replacement stock were set to be young, adult, and old with percentage coverage of 10, 50, and 40%, respectively, as shown in Table 5.

According to the local community (100% respondents), the coenurosis is increasing over the past 10 years and that it is the problem of the adults. The question was present to enable them explain what they observe from their diseased sheep or goats. They explained clinical sign like circling, head tilt to side, blindly walk, and lagging back from the flock; and circling is more towards the left side. This was from 66% which revealed that the probability of observing clinical sign towards left is high.

### Preliminary economic loss implication of *C. cerebralis* in sheep and goats

The economic implications of coenurosis were assessed based on direct losses due to death during last year (2014) from total interviewee and reduction in market price due to esthetic value (indirect losses). The numbers of animals died during the last year were 590 heads of sheep and goats. There are six average heads of sheep and goats per respondents. Out of the 412 total small ruminants examined, 50 were clinically diseased that succumb to market price depreciation. The wage loss due to treatment seeking for their diseased animals, and treatment cost for diseased animal during the 5 months of this study was included in the calculation.

According to respondents, the actual price of healthy adult sheep and goats were ranging from 550 to 800 Ethiopian Birr (ETB) with an average of 675 ETB, while the coenurosis infected animal price was between 150 to 500 ETB range with average price of 325 ETB. So, the producer loss 350 ETB (675–325ETB) from each coenurosis infected animals. Meanwhile, direct losses due to death were estimated by the number of animals died multiplied by the average price of healthy animals. Thus, the financial losses from mortality during last year (2014) estimated to be 398,250 ETB (19,432.61US\$) from 590 deaths. Whereas average losses from esthetic value from 50 clinically diseased animal were about 17,500 ETB. The wage loss was calculated as the projection of Ethiopian household budget per day (25 ETB) times the total number of respondent who have taken their animals to the clinic. We assume that respondents visit clinic on average 1 day. Hence, the wage loss was estimated to be  $25 \times 50 = 1250$  ETB. The average prices for treatment were 60 ETB ( $60 \times 52 = 3120$ ). The indirect loss were calculated as  $IL = 5\% \times NAS \times PH \times CPB \times 15$  kg which is 65,318.4 birr.

**Table 3** Management of infected heads

Management system	No. of HHS	Percentage
Burying	9	18
Burning	6	12
Giving to dogs	35	70
Total	50	100

**Table 4** Dog related factors for spread of coenurosis

	Do you own dog		Dog feces management			Dog deworming	
	Yes	No	Burying	Live it on field	Collect at kosii	Yes	No
No. of HHS	20	30	8	72	8	4	46
Percentage	40	60	16	68	16	8	92

Where PH = 0.126, CPB = 80birr, and NAS = 8640 animals. The total economic losses was the sum of direct loss and indirect loss which is  $398,250 + 65,318.4 + 3120 + 1250 + 17,500 = 485,438.4$ ETB per year.

## Discussion

This cross-sectional study was primarily conducted to assess the prevalence of Coenurosis in Legahida district of subsistence farmers owning sheep and goats and to investigate potential risk factors related to the cyst harboring. Secondly, preliminary estimate was made on the economic burden inflicted to the farmers by this disease of domestic shoats. This is important because quantitative assessment of this disease will provide with good evidence for political and financial win to promote its control and prevention. In addition, the economic burden estimation is a good tool of disease cost analysis and looks for preventive technique/s that best benefit the society and country's economy.

Coenurosis is endemic in Ethiopia, especially in the highlands where 75% of the sheep population occurs (Achenef et al. 1999). The report of Abraha (2007) also describes *C.cerebralis* as the major health problems of sheep in the Atsbi Womberta Woreda, Tigray. The study conducted using participatory epidemiology method to sort out the challenging sheep and goats disease in Yabello and Taltalle Woreda. Also reported were sirgo/coenurosis (72%), CCPP (20%), and PPR (3%) which were the three prominent diseases that are prevailing in the weredas (Nenni et al. 2012). In this study, the overall prevalence of *C.cerebralis* was found to be 12.6%. This finding is relatively lower than the report in the highland sheep of Ethiopia in which 19% was reported by Achenef et al. (Achenef et al. 1999). This could be due to the large population of sheep in the area which comprises 75% (Bekele et al. 1992) and the agro ecology of the area (cool temperature and high humidity) which may be conducive for survival of

*T. multiceps* eggs. As literature suggests, that under high levels of humidity, the eggs persist for more than 30 days, while at high temperature, they die in a few hours (Scala and Varcasia 2006). In addition to these, Achenef et al. (Achenef et al. 1999) reported that the presence of freely roaming dogs on grazing land greatly contributes to the existence of the disease in highland sheep. Similar results were reported by (Nenni et al. 2012) in which overall prevalence was 11.5% in Yabello District of Borena with almost similar agro-ecological zone where the current study was conducted. Other similar results were also reported in some other studies. Vink et al. (1997) and Afonso et al. (2011) reported 13.8 and 9.1% in goats in Tete Province, Mozambique, respectively.

The prevalence 20.7% in sheep is higher comparing to prevalence 9.6% in goats, and this difference is statistically significant ( $P = 0.017$ ), and the OR estimate describes that sheep have 3.97 time more odds of getting coenurosis (Table 1). Similar to this study, 9.7% prevalence from naturally infected goat and sheep was reported by (Nenni et al. 2012) in Yabello district. In other studies, also prevalence 9.1% from naturally infected goat was reported by Afonso et al. (2011) in Tete municipal abattoir, Mozambique, and 18.65% prevalence in sheep was reported from Iran by Tavassoli et al. (2011). This difference might have been arising from the difference in sample size. In this study, many goats were presenting to the slaughtered slabs, and sheep were small. But in the aforementioned authors' report, the proportion of sample size in between these two species was nearly the same. This indicates that sheep are prone to coenurosis, and this difference was may be also due to goats are browsers, and their chance of getting the *T.multiceps's* eggs are rare.

The age specific prevalence among age groups were significantly different ( $P = 0.000$ ) (Table 1), indicating young and adults are more susceptible to the cyst as compared to older animals. The reasons for the lower prevalence of the disease in older sheep and goats may be explained by the presence of an acquired immunity (Vink et al. 1997), and the higher prevalence in young was due to the management system, since the kids/lambs are kept in homestead (village) before weaning age with soil licking habit, so they have more likely to harbor the eggs. Achenef et al. (1999) in Debrebirhan Ethiopia reported the high prevalence of the disease in 6 to 24 months age. In Italy, Scala and Varcasia (2006) also reported 2–3 years of age sheep were highly affected by coenurosis, which were similar with this study's report. Other similar study in Yabello district reported prevalence of 29% in young

**Table 5** Age categories for breeding replacement of sheep and goats

Age	No. of HHS	Percent
Young	5	10
Adult	25	50
Old	20	40
Total	50	100

group (Nenni et al. 2012). One hundred percent of the interviewed respondents also complained the increment of the cases in the young and adults (goromtii locally) thus, supplementing the PM findings.

Clinical signs of coenurosis, such as circling, depression, head pressing, and blindness, were reported previously in other studies (Achenef et al. 1999); (Nourani and Kheirabadi 2009); (Vink et al. 1997); (Gicik et al. 2007), were recorded also in this study. The *Teania multiceps's* cyst can be localized in any part of the brain. This study revealed that the location of the cyst is mostly in the cerebrum. This is similar with the findings of the Gicick et al. (2007) (96.7%), Achenaf et al. (1999) (96%), and Deressa et al. (2012) (94.4), where they reported the cyst location in more proportion in the cerebral hemispheres. The presence of cysts in the median fissure also reported by Vink et al. 1997), (8%) and Tavassoli et al. (2011) (1.5%). This study also had shown that 1.16% of the cysts is in the median fissure. It is unclear why the majority of cysts settled in the left hemisphere. The questionnaire survey also indicated that 56% of interviewed respondents expressed that the sick animals were mostly circling towards the left and thus, complimented with the post mortem findings. According to the literature, circling is frequently towards the side of the brain in which the cyst is located (Dunn 1978).

About 0.55% apparently clinically health animals also harbored the cyst. This is smaller than the reports by Nenni et al. (2012) (2.4%) in Yabello district and Achenaf et al. (1999) 3% from non-clinical in Debrebirhan Ethiopia. The size of the cyst(s) in apparently healthy animals were from less than 1–2 cm in diameter. This probably are small to create pressure and hence to induce clinical signs which also forwarded by Achenaf et al.(1999). Among the clinically affected animals, post-mortem examination revealed that 96% of the cases found with cysts, on the other hand, two out of 50 clinically infected animals found without cyst, but one of these was found with *O. ovis*. This revealed that the probability of getting cyst in clinically diseased animal was very high. The correlation analysis revealed that there is high correlation between clinical disease and cyst recovery from the brain with correlation coefficient of 0.956. Desouky et al. (2011) reported of 25 animals examined from clinically diseased sheep and goats; 100% revealed the presence of *T. Multiceps's* cyst in the brain, and 100% prevalence was recorded in 37 clinically sick sheep by Achenef et al. (1999).

In this study, the cyst(s) number recovered from brain was 1 to 5 cysts. This was similar with the findings of Achenaf et al. (1999) and (Gicik et al. 2007; Tavassoli et al. 2011) who reported 1 to 8 and 1 to 4 cysts, respectively. Thus, strongly indicating coenurosis is a common cause of nervous disorder in the Legahida sheep and goats. The sizes of the cysts were found between 0.8 and 6 cm which is similar with findings of Nenni et al. (2012) in which 0.8 to 6.5. Gicik et al. (2007) and Achenaf et al. (1999) also reported similar findings in which

they recovered 1.5 to 6.2 cm and 0.8 to 6.5 cm in diameter of cyst.

Out of the total interviewee, 72% of them possess dogs and all of them responded that foxs (Gedala locally) was the primary predator of sheep and goats because of the close relation of dogs and fox. In addition to this, the livestock are always grazed in communal pastures of the Legahida district, and 100% of respondents replied that they keep their kids and lambs in homestead or village with 73.4 and 26.6% of respondents complained soil licking (village grazing) and hand feeding habits of kids/lambs, respectively; thus they likely have the chance to harbor parasite eggs.

The survey carried out in Addis Ababa (Ethiopia) report that a total annual financial loss due to condemnation of slaughtered animal brain or carcass due to coenurosis was estimated at 8330 Ethiopian birr (490 US\$) (Deressa et al. 2012). This study also assures that coenurosis causes high economic losses in small ruminant producers. The estimated monetar loss due to coenurosis was 467,938.4 ETB. In addition to this, about 40% interviewed respondents explained that they rare their breeding stock replacement which was also reported by Bedane et al. (2009). This statement also goes with reports of Scala and Varcasia (2006) from Italy who approved that coenurosis causes high losses in sheep farms because the disease affects young animals that the farmers grow up each year as replacements of the older individuals. According to this study, coenurosis is one of the major contributors to sheep and goat mortalities and results in great economic losses in Legahida district, and effective control measures must be taken.

This study proved that coenurosis is a common problem of Legahida district. It contributes to young sheep and goat mortalities. Age and species are significant contributor risk factors in the distribution of coenurosis in the study population. The questionnaire survey revealed that there is a poor management of head from slaughtered shoats (they give to dogs); dog deworming practice is very poor, dog feces management is poor, and restriction of their stocks from the access of wild canids is poor. Most of the respondents wrongly understand the source of the disease and do not know the transmission mechanism. This survey also revealed that the *C. cerebralis* causes huge economic loss in Legahida district. Therefore, prohibition of backyard slaughter of small ruminant and construction of slaughter houses will prevent dog access to infected head, and dogs should be dewormed frequently, and further extensive molecular and epidemiological studies are needed to ascertain among others if there are different species *Teania multiceps* causing coenurosis.

**Acknowledgements** We extend our gratitude to the Jimma University College of Agriculture and Veterinary Medicine for financing this project. We are thankful to the Community of (Livestock owners) for their cooperation and contributing their rich indigenous knowledge freely and

honestly, and our heartfelt gratitude goes to Mr. Gemechu, the staff member of pastoral development bureau for giving information about our study area and different information he provided.

**Compliance with ethical standards** This study was ethically reviewed and approved by the Jimma University College of Agriculture and Veterinary Medicine's Research and Postgraduate Office. "All applicable international, national, and/or institutional guidelines for the care and use of animals were followed." The Organ/tissue samples were taken after the animals were slaughtered, and no suffering was inflicted to the animals due to this research.

**Conflict of interest** The Authors has nothing to declare

### Appendix 1 Picture of clinically diseased animals and *T. multiceps's* cysts and scoleces



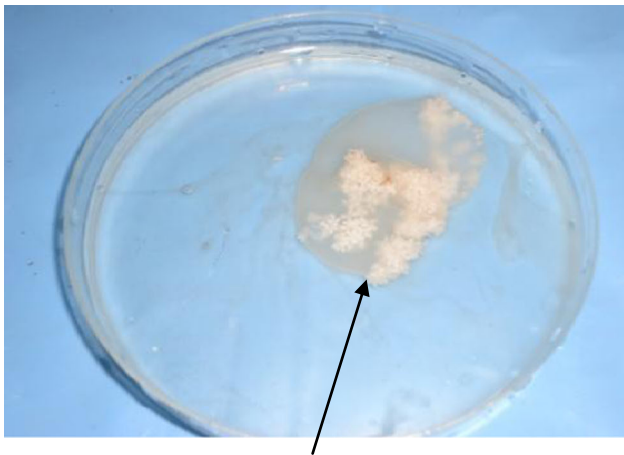
Clinically diseased goats with head tilted to side.



Cyst on LH of adult goat

Cyst on RH of adult goat

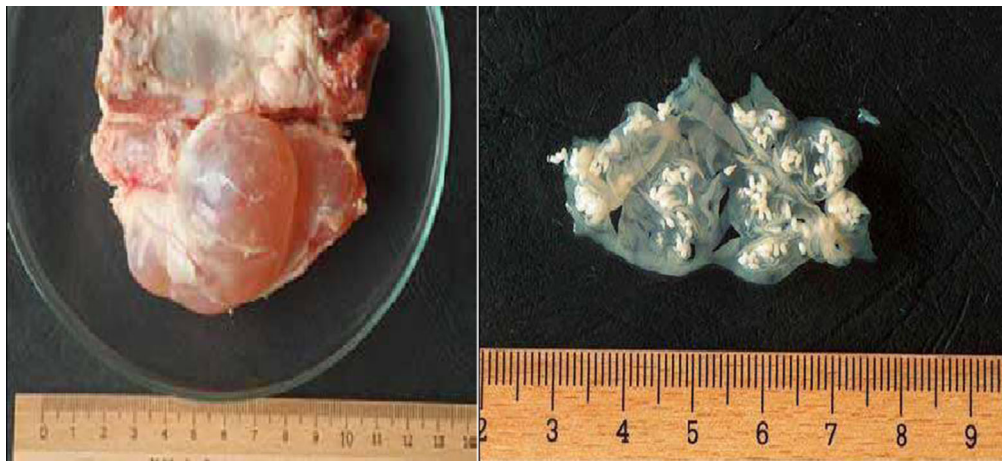




Cyst with multiple scolexes



Single scolex with rostellar hooks under microscope



Coenurus cyst from the lumbar region Numerous white cluster of scolices in the internal layer of the cyst

## References

- Abraha G (2007) Major animal health problems of market oriented livestock development in Atsbi Womberta woreda, Tigray regional state. DVM thesis Addis Ababa University Debre-zeit Ethiopia
- Achenef M, Markos T, Feseha G HA, Tembely S (1999) *Coenurus cerebralis* infection in Ethiopian highland sheep: incidence and observations on pathogenesis and clinical signs. *Trop Anim Health Prod* 31(1):15–24
- Adane P, Kumsa B, Hiko A, Afera B (2015) Prevalence of *Coenurus cerebralis* in small ruminants slaughtered at Hashim export abattoir, Debre zeit, Central Oromia. *Eur J Appl Sci* 7(2):56–63
- Afonso SMS, Mukaratirwa S, Hajovska K, Capece BPS, Crist'ofol C, Arboix M, Neves L (2011) Prevalence and morphological characteristics of *Taeniainmulticeps* Cysts (*Coenurus Cerebralis*) from abattoir-slaughtered and experimentally infected goats. *J Neuroparasitology* 2(5)
- Avcioglu H, Terim KA, Yildirim A (2012) Clinical, morphological and histopathological features of bovine coenurosis: case reports. *Rev Med Vet* 163(6):295–298
- Bedane A, Berecha B, Numery A, Fufa D, Tilahun N, Birhanu S (2009) Survey of major livestock diseases in pastoral and agro-pastoral communities of borana zone, southern Ethiopia. Technical report: 64
- Bekele T, Woldeab T, Lahlou-Kassi A, Sherington J (1992) Factors affecting morbidity and mortality on-farm and on-station in the Ethiopian highland sheep. *Actatropica* 52(2–3):99–109
- Brook L (1983) The seasonal occurrence of fasciolosis and some other helminth diseases of sheep in four selected site of Ethiopia. MSc thesis. Addis Ababa University, Debre-Zeit, Ethiopia
- Central Statistical authority (CSA) (2015) Federal democratic republic of Ethiopia, central statistical agency, agricultural sample survey 2013/2014 (2006 E.C.): report on livestock and livestock characteristics, statistical *bulletin* 447: 39
- Deressa A, Tilahun T, Tadesse A, Gebrewold G, Beyene M, Pal M (2012) Assessment of *Coenurus cerebralis* and its economic impact in sheep brain harvested at Ethiopian health and nutrition research institute, Ethiopia. *Int J Livest Res* 2(2):217–226
- Desouky EAA, Badaway I, Refaat RA (2011) Survey on coenurosis in sheep and goats in Egypt. *Veterinariaitaliana* 47(3):333–340

- Dunn AM (1978) Veterinary helminthology. William Heineman Medical Books Ltd, London, pp 248–302
- Ethiopian Customs and Revenue Authority (ECRA) (2012) Raw data on the type, volume, value and destination of export items from Ethiopia. Addis Ababa, Ethiopia
- Edwards GT, Herbert IV (1982) Observations on the course of *Taenia multiceps* infections in sheep: clinical signs and post-mortem findings. *Br Vet J* 138(6):489–500
- Gıcık Y, Kara M, Arslan MO (2007) Prevalence of *Coenurus cerebralis* in sheep in Kars Province, Turkey. Department of parasitology, faculty of veterinary medicine, University of Kafkas. *Bull-Vet Inst Pulawy* 51(3):379–382
- Kosgey IS (2004) Breeding Objectives and Breeding Strategies for Small Ruminants in the Tropics. PhD. Thesis. Wageningen University, the Netherlands: 272
- National Agricultural Research Institute (NARI) (2003) How to tell the age of sheep and goats. Livestock Research Programme – Labu, Morobe Province, Papua New Guinea
- Nenni Sh, Bedane A, Feyissa B, Zewdu E, Getachew G (2012) Study on Prevalence and Economic Implications of *Coenurus Cerebralis* in Sheep and Goats in Yabello District, Borana Zone, and southern Ethiopia. A DVM Thesis Jimma University College of Agriculture and Veterinary Medicine Jimma, Ethiopia
- Nourani H, Kheirabadi KP (2009) Cerebral coenurosis in a goat: pathological findings and literature review. *Comperative Clin Pathol* 18(1):85–87
- Oge H, Oge S, Gonenc B, Ozbakis G, Asti C (2012) Coenurosis in the lumbar region of a goat: a case report. *Vet Med* 57(6):308–313
- Scala A, Varcasia A (2006) Updates on morphobiology, epidemiology and molecular characterization of coenurosis in sheep Dipartimento di biologiaanimale, sezione di parasitologia, facoltà di medicinaveterinaria, universitàdeglistudi di sassari, sassari, /taly. *Parassitologia* 48(1–2):61–63
- Tavassoli M, Malekifard F, Soleimanzadeh A, Tajik H (2011) Prevalence of *Coenuruscerebralis* in sheep in NorthWest of Iran. *Vet Res Forum* 2(4):274–276
- Thrusfield M (2005) Veterinary epidemiology: veterinary clinical studies royal (dick) school of veterinary studies university of Edinburgh, 3rd edn. Edinburgh, Scotland, p 233
- Torgerson PR, Dowling PM, Abo-Shehada MN (2001) Estimating the economic effects of cystic coenurosis. Part3: Jordan, a developing country with lower-middle income. *Ann Trop Med Parasitol* 95(6): 595–603
- Uslu UĐUR, Guclu FEYZULLAH (2007) Prevalence of *Coenurus cerebralis* in sheep in Turkey. *Medycyna Weterynaryjna* 63(6): 678–680
- Vink WD, Van Keulen KAS, Debalogh KKIM, Lopes Pereira CM (1997) A field survey on several causes of central nervous disorders in goats in tete province. Mozambique: 37
- <http://www.ocha-eth.org/Maps/downloadables/OROMIYA.pdf>. Visited on 27 December 2015