

Prevalence of Cystic Echinococcosis in One-Humped Camels Slaughtered at Addis Ababa Municipality Abattoir, Ethiopia

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Abstract

Cystic Echinococcosis (CE) is one of the most important zoonotic and economically important disease prevalent in different parts of Ethiopia and the world at large. This survey aimed to estimate the prevalence, identify associated risk factors, and tissue distribution patterns of CE in camels slaughtered at Addis Ababa municipality abattoir. Out of 416 one-humped camels examined during meat inspection, hydatid cysts were detected in 159 (38.22%) of them. The cyst was detected more frequently in the lungs (37.02%) followed by liver (35.1%), but very few camels had cysts in their heart, spleen, and kidneys. Significantly higher ($p < 0.05$) prevalence of hydatid cyst was observed in female than male camels (48.05% vs 32.4%), in adult camels than young ones (53.1% vs 20.2%), and camels with good (25.0%) and medium body conditions (67.4%) compared to those in poor body condition (7.7%). The study further revealed that out of 768 cysts collected from the different organs, 169 (22%), 215 (28%) and 384 (70.57%) were abscessed/calcified, sterile and fertile cysts, respectively. About 54% (n=235) of the cysts in the lungs and 45% (n=148) in the liver were fertile. Of which, 146 (62.13%) cysts in lungs and 87 (58.78%) cysts in liver were viable. In conclusion, this study revealed a high prevalence of CE with a higher proportion of fertile and viable cysts in the pastoral areas. Therefore, to reduce the wide spread occurrence of CE and hence the presumed public health and socio-economic impacts, extension work on safe disposal of infected offal and dead animals, awareness creation to the community about the disease, construction of abattoirs with appropriate disposal pits and strict meat inspection should be given due consideration.

Keywords: Abattoir; *Camelus dromedarius*; Cystic echinococcosis; Prevalence; Risk factor.

Introduction

The one humped camel (*Camelus dromedarius*), by the virtue of their excellent adaptive behavior, play significant role in the livelihood of pastoralists living in most arid and semi-arid countries of the tropics including Ethiopia. It is almost everything to pastoralists as source of food and power, cash and prestige, and means of storing wealth (Zelege and Bekele, 2000). Moreover, quite huge numbers of camels are also slaughtered in the capital city and some towns in the eastern and south eastern part of the country. At the moment camels are also becoming one of the export animals to Arabian Peninsula and Egypt (SOS-Sahel Ethiopia, 2007; Tefera and Abebe, 2012).

Despite their significant socio-economic contributions, camels in the pastoral areas of Ethiopia are still facing shortage of water, feed, housing and health care services (Zelege and Bekele, 2000; Keskes *et al.*, 2013; Regassa *et al.*, 2015). Their natural semi-arid to desert habitats, together with the poor husbandry practice, are known to induce severe stress conditions in camels and ultimately make them susceptible to many diseases and ailments (Abbas *et al.*, 1993; Volpato *et al.*, 2015). Moreover, the broader home range of the camel in pastoral areas, the poor veterinary service and improper disposal of offals and cadavers are known to expose the camel to various pathogens including eggs of parasites. Specifically, the large number of dogs kept by the pastoralist and the wild carnivores freely roaming in the area can potentially contaminate the communal watering points and the pasture with eggs of *Echinococcus granulosus* (Elham *et al.*, 2014)

Cystic echinococcosis (CE), caused by the cestode parasite called *Echinococcus granulosus*, is one of the most important zoonotic and economically important diseases prevalent in different parts of the country and the world at large (Dallimi *et al.*, 2002; Ito *et al.*, 2003; Latif *et al.*, 2010; Ibrahim 2010). Cystic echinococcosis affects most livestock including cattle, sheep, goat, pig and camel and induces significant economic loss through organ condemnation, decreased hide value, carcass weight, and decreased productivity (Oryan *et al.*, 1994; Dakkak, 2010). Because of lack of satisfactory test to diagnose CE in living livestock (Craig, 1997; Njoroge *et al.*, 2002), the diagnosis is mainly dependent on meat

inspection in the abattoirs (Njoroge *et al.*, 2002; Acosta-Jamett *et al.*, 2010; Ibrahim, 2010).

Based on several cross-sectional studies conducted in Ethiopia and abroad, cattle, sheep and goats appear to be the most common intermediate hosts for *Echinococcus granulosus*; recent studies in Sudan and Turkana however suggest that camels are equally important intermediate host (Omer *et al.*, 2004). In Ethiopia, except the few previous reports (Woldemeskel *et al.*, 2001; Muskin *et al.*, 2011; Boru *et al.*, 2013; Hayer *et al.*, 2014; Debela *et al.*, 2015; Regassa *et al.*, 2015) information available on CE in camels is limited to small part of the country and are fragmented to conclude on the role of camels in the epidemiology of the disease. Therefore, the present study was designed to estimate the prevalence, identify associated risk factors, characterize the cyst and illustrate its tissue distribution in camels slaughtered at Addis Ababa municipality abattoir, Akaki branch.

Material and Methods

Study Area

The study was conducted from October 2018 to May 2019 at Akaki abattoir, which is owned by the Addis Ababa abattoir enterprise and located in Addis Ababa city. The city is located at 9°1'48' North and 38° 44'-24' East at an average altitude of 2,500meters above sea level. Although the camel meat is not widely known in Addis Ababa, camels are slaughtered for the Somali and other Muslim communities who live or stay for short in the city (Salih *et al.*, 2011). The camels slaughtered at the abattoir were originated from Borana and Kereyu pastoral areas and Minjar-Shenkora district.

Borana pastoral area is located at approximately 600 kms South of Addis Ababa at an altitude ranges from 970 meters above sea level in the south bordering Kenya to 1693 meters above sea level in the Northeast. The area is characterized by an arid and semi-arid climate, with pockets of sub-humid zones. The rainfall in the area is bimodal where the average annual rainfall varies between 350 mm and 900 mm. The rainfall of the area is erratic by nature and there are four distinct seasons interspersed by long rainy season (expected between March and May) and the short rainy season (between October and November) (Galma, 2015).

Kereyu Pastoral area, circumscribed in Fentale district, is located at about 250 km East of Addis Ababa at an altitude of 930 meters above sea level. The tribes of Kereyu pastoralist occupy the arid lands around the Awash River down in the rift valley for pasture for their cattle, goats and camel (Tefera and Abebe 2012). The area has an average annual rainfall of 504 mm. The mean annual maximum and minimum temperature are 32.40 and 18.5°C, respectively. Pastoralism and agro-pastoralism are the main livelihood systems in the area (Beyene and Gudina 2009).

Minjar-Shenkora is one of the districts in the Amhara Regional state of Ethiopia, located at the southern end of the North Shewa Zone at about 129 km East of Addis Ababa. The district is bordered on the east, south and west by the Oromia Regional state and on the northwest by Hagere Mariam. Its altitude ranges from 1,040 to 2,380 meters above sea level. The average temperature ranges from 14 °C to 27 °C while the annual rainfall ranges between 780 and 900 mm. The district is known with its scattered bushes, shrubs and acacia trees (Ferede *et al.*, 2014).

West Hararghe zone is located at 7°50'–9°50' N; 40°00'–41°25' E and 1200–3060 meters above sea level. The zone shares boundaries with Afar Regional State, Somali Regional State, as well as the east Hararghe Zone. It has three distinct agro-ecologies that consists of highland (17.5%), mid highland (28.5%), and lowland (54.0%) and have two rainy seasons, the short rainy season and the main rainy season, with a mean annual rainfall ranging from below 700 mm in the lowlands to nearly 1200 mm at higher altitudes (Ketema *et al.*, 2018). The farming system is mainly characterized by pastoralism and agro-pastoralism. In addition to other livestock, the zone has high camel breeding potential.

Study population

The study population included the total number of camels presented to and slaughtered in the abattoir. Camels purchased from different markets were transported to the abattoir by trucks and kept at lairage for 3 to 4 days. Camels in the pastoral area (their original sites) browse on bushes and shrubs, but grasses may be consumed rarely when shrubs or trees are not available. The browse species includes the family *Chenopodiaceae*, *Acacia brevispica*, *Opuntia ficus indica*, *Dichrostachys ciniarea* and *Euphorbia tirucalli* (Bekele and Kibebew, 2002). The main sources of water for camels in the areas include wells, ponds and rivers (Wolde, 1991). The watering sites are usually visited

once per week by large numbers of camels and other animals at a time from the surrounding as well as from distant areas. Mostly the pond and river water sources are shared by wild animals too (Mirkena *et al.*, 2018). Camels in the pastoral areas are used for packing, transportation, ploughing and traction purposes and as source of cash income, milk and meat (Mehari *et al.*, 2007).

Study animals and sample size

The sample size was calculated using the formula given for simple random sampling (Thrusfield and Brown, 2018) with a previous prevalence of 65% (Re-gassa *et al.*, 2015), 95 % confidence level and 5% desired absolute precision. Accordingly, the sample size was determined to be 350. However, 66 more camels were included with the intention of maximizing the sample size for better precision. The sampling procedure was carried out using systematic random sampling (Thrusfield and Brown, 2018), whereby every third camel walking into the lairage was selected and marked.

Study methodology

Antemortem examination

During each regular visit, all the camels brought for slaughter were inspected while entering into the lairage for the presence of any observable abnormality. The general behavior of the animal, body condition, gait, posture, clinical signs suggestive of disease and abnormality of any type were registered (Gracey *et al.*, 1999) and judgment was made based on FAO recommendation (Herenda *et al.*, 1994).

Data about the age, sex, origin and body condition score of the selected camels were recorded before slaughtering. The age of the camels was estimated using rostral dentition (Bello *et al.*, 2013) and then categorized as young (less than 5 years) and adult (≥ 5 years of age) for ease of data analysis. The body condition score of the camels were assessed according to Faye *et al.*, (2001) and then grouped as poor (score 1), medium (score 2 and 3) and good (score 4).

Post Mortem Examination

Following slaughter and evisceration, a thorough and systematic inspection of the visceral organs particularly the lungs, liver, spleen, heart and kidneys

were made for presence of hydatid cyst using visual inspection, palpation and multiple incisions, when required. The pathological lesions were differentiated according to guidelines on meat inspection for developing countries (Herenda *et al.*, 1994). Cysts of each organ were counted and differentiated as calcified and non-calcified based on their consistency and appearance. The study animals were considered as positive if at least one cyst was found in one or more of the organs examined. All non-calcified hydatid cysts (when the number of cysts in the organ is ≤ 3) and three randomly selected non-calcified hydatid cysts (when their number on the organ is >3) were collected. Briefly, the non-calcified cysts were removed whole and placed in clean polyethene bags, labeled properly and transported to the laboratory of National Artificial Insemination center (at Kaliti, Addis Ababa) for further examination.

Cyst fertility and viability tests

The surface of the cyst was wiped off or blotted with tissue paper and/or gauze and then, to reduce intracystic pressure, part of the fluid was drained with a 21-gauge needle attached with a 12 ml syringe. By cutting the cyst wall with scalpel and scissors, the remaining content of the cyst was poured into a clean petri dish. The fertility of the cyst was determined by considering the presence of protoscolices (as white dots on the germinal epithelium or broad capsule or hydatid sands suspended in the fluid) (Urquhart *et al.*, 1996; Bowman, 2014). The cysts which contained no protoscolex as well as suppurative or calcified cyst were considered as non-fertile cyst.

All the fertile cysts were then subjected to viability test. The viability of the protoscolices was assessed by examining them under a microscope (40X) following the application of 0.1% aqueous eosin solution (Smyth and Barrett, 1980). The protoscolices were considered viable when they didn't take the eosin stain.

Statistical analysis

All the collected data were entered into Microsoft Excel spreadsheet coded and then analyzed using STATA statistical software (STATA, 2013; window version 13.1). Association between various risk factors (sex, age, origin and body condition score) and the prevalence of *hydatidosis* was assessed by using chi-square independent test. Moreover, univariable and multivariable logistic regression analyses were carried out to assess the level of significance. In all the analysis, significance was set at $p < 0.05$.

Results

The overall prevalence of CE in camels in the current study was 38.22% (159 out of 416 camels). The hydatid cysts were detected more frequently in the lungs (37.02%) followed by the liver (35.1%), but very few camels had cysts in other organs (heart, spleen and kidney) (Table 1). Majority of the slaughtered camels had hydatid cysts both in their liver and lungs.

Table 1. Prevalence and organ level distribution of hydatid cysts in the examined camels (n = 416).

Tissue /organ	No positive	Prevalence (%)	95% CI
Lung	154	37.02	32.36 – 41.68
Liver	146	35.10	30.49 – 39.70
Kidney	2	0.48	-0.19 – 1.15
Spleen	1	0.24	-0.23 – 0.71
Heart	1	0.24	-0.23 – 0.71
Lung +Liver	143	34.37	29.79 – 38.96
Lung + Kidney	2	0.48	-0.19 – 1.15
Over all	159	38.22	33.53 – 42.91

Relatively higher prevalence and likelihood of occurrence of hydatid cyst were observed in female camels (48.05%, OR 1.93), in old camels (53.07%, OR 4.5), camels originated from Kerayu (43.24%, OR 1.72), and camels with medium body condition (67.4%, OR 22.86) than in the category/ies of the respective risk factors. With the exception of the origin ($p = 0.173$), the difference in the prevalence of hydatidosis between or among the categories of the other considered risk factors (age, body condition score and sex) were statistically significant ($p < 0.05$) (Table 2).

Table 2. Prevalence and logistic regression analysis of hydatid cyst in camel by the putative risk factors.

Variable		No exam ined	No (%) positive	Crude OR (95% CI)	Adjusted OR (95% CI)	p- value
Age group	Young	188	38 (20.21)	1	1	
	Adult	228	121 (53.07)	4.5 (2.9 - 6.9)	3.7(2.21 – 6.12)	0.000
BCS	Poor	104	8 (7.69)	1	1	
	Medium	172	116 (67.44)	22.86 (11.29 – 54.69)	35.6(14.4 – 88.02)	0.000
	Good	140	35 (25.00)	4.0 (1.77 – 9.05)	4.7(2.01 – 11.10)	0.000
Sex	Male	262	85 (32.44)	1	1	
	Female	154	74 (48.05)	1.93(1.28 – 2.90)	1.95(1.10 – 3.47)	0.023
Origin	Borana	101	31 (30.69)	1	1	
	Kereyu	111	48 (43.24)	1.72(0.98 – 3.03)	1.64 (0.80 – 3.34)	0.173
	Minjar Shenkora	92	34(36.96)	1.32(0.73 – 2.41)	1.25 (0.60 – 2.60)	0.558
	West Hararghe	112	46 (41.07)	1.57(0.89 – 2.77)	1.32 (0.65 – 2.66)	0.446

BCS = Body Condition Score, OR = Odds Ratio, CI = Confidence Interval

Out of 768 cysts collected from the different organs, 169 (22%), 215 (28%) and 384 (70.57%) were found to be abscessated / calcified, sterile and fertile cysts, respectively. The proportion of fertile cysts was higher in the lungs (54.4%) followed in the liver (45.12%) and kidneys (20%). Of the fertile cysts collected from lungs and liver, 146 (62.13%) and 87 (58.78%) were viable. However, all the cysts collected from kidneys, spleen and heart were non-viable (Table 3).

Table 3. Cyst fertility and viability in different organs of study camels

Organ	No of collected cysts	Sterile cyst No (%)	Calcified cysts No (%)	Fertile cyst No (%)	Viable cysts No (%)
Lung	432	110 (25.46)	87 (20.14)	235 (54.40)	146 (62.13)
Liver	328	102 (31.10)	78 (23.78)	148 (45.12)	87 (58.78)
Kidney	5	1(20)	3 (60)	1(20)	0
Spleen	2	1(50)	1 (50)	0	0
Heart	1	1(100)	0	0	0
Over all	768	215 (28.0)	169 (22.0)	384 (70.57)	231 (60.16)

Discussion

The prevalence of camel hydatidosis recorded in this study (38.22%) is relatively higher than the previous reports 23% by Debela *et al.* (2015), 28.7% by Hayer *et al.* (2014), 22.6% by Muskin *et al.* (2011) and 18.8% by Woldemeskel *et al.* (2001) from different parts of Ethiopia. However, comparably higher prevalence (61.4 to 65%) than the current study was also reported in Ethiopia (Regassa *et al.*, 2015; Boru *et al.*, 2013). Higher prevalence values were also reported from other African countries such as 61.4% from Kenya (Njoroge *et al.*, 2002), 45% from Sudan (Elmahdi *et al.*, 2004) and 44.4% from Nigeria (Okolugbo *et al.*, 2013). The prevalence difference observed between these studies could be partly explained by the difference in the ecology, husbandry, livestock stocking intensity, population of the definitive hosts and the socio-cultural practices. Specifically, the most common production practices that may increase the risk of exposure of farm animals to hydatidosis include improper disposal of dead animals, the access of dogs to the offals of slaughtered animals, absence of regular deworming of dogs, communal and mixed-species grazing, and unrestricted use of watering points by camels, stray dogs and other wild canidae (Azlaf and Dakkak, 2006; Christodoulopoulos *et al.*, 2008; Elham *et al.*, 2014).

The prevalence of hydatidosis was significantly higher in female camels (OR 1.95, $p = 0.023$) than the males and in old camels (OR 3.7, $p = 0.001$) than young camels. This finding is in line with the reports of Muskin *et al.* (2011), Gizachew *et al.* (2013), Boru *et al.* (2013) and Debela *et al.* (2015) from Ethiopia, Abdul-Salam and Farah (1988) from Kuwait, Ibrahim *et al.* (2011) from Sudan and Elham *et al.* (2014) from Iran. These might be related to the higher chance of direct or indirect contact with freely roaming dogs while the female camels are brought and kept around the homesteads till they get milked. Moreover, as female animals are kept for prolonged years for milk production, the possibility of acquiring and sustaining infections will also increase. Given the high reproductive capacity of *Echinococcus granulosus*, a single infected dog can excrete feces with a large number of parasite's eggs that can contaminate wide range of the foraging areas and watering points (Gemmell, 1990; Parija, 2004).

In the present study, the hydatid cysts were detected more frequently in the lungs (37.02%) followed by the liver (35.1%). Comparable reports were also made previously from Ethiopia (Woldemeskel *et al.*, 2001; Muskin *et al.*, 2011; Gizachew *et al.*, 2013; Debela *et al.*, 2015) and elsewhere (Anwar and Khan,

1998; Ibrahim and Craig, 1998; Sharrif *et al.*, 1998; Njoroge *et al.*, 2002; Ahmadi, 2005; Okolugbo *et al.*, 2013; Elham *et al.*, 2014). In contrary, Ibrahim (2010) from Saudi Arabia and Boru *et al.* (2013) and Hayer *et al.* (2014) from Ethiopia reported that the liver is more frequently affected organ than the lungs. In the current study, it is also noted that concurrent infection of both liver and lungs was equally common like infection of either of the organs alone.

The higher frequency of infection in lungs and liver might be due to the fact that the migrating echinococcus oncospheres that get into the subepithelial capillaries of the intestine or the lacteal has to pass first the great capillary bed of the hepatic and pulmonary filtering system before reaching any other organ (Brown *et al.*, 2007; Kebede *et al.*, 2009). Owing to the largest capillary beds in the lungs, oncospheres entering the vena cava with the lymph will be first filtered out and trapped in the lung and concomitantly forms the cyst than in any other organ (Brown *et al.*, 2007).

The infectivity potential of the cysts revealed that 70.57% of the cysts were fertile, of which 60.16% were viable, which is in line with Muskin *et al.* (2011) and Okolugbo *et al.* (2013) who reported 50% and 79% fertility in camels from Ethiopia and Nigeria, respectively. Although not statistically significant, cysts from the lungs were more fertile and viable than the liver. In Ethiopia, Muskin *et al.* (2011), Boru *et al.* (2013) and Hayer *et al.* (2014) also reported relatively more fertile cysts from lungs than the liver. On the contrary, the studies conducted by Elham *et al.* (2014) in Iran and Ibrahim *et al.* (2011) in Sudan showed that hydatid cysts of the liver have higher fertility rate than that of lungs. Our observation can be explained by the relative softer consistency of the lung tissue, compared to liver, which might favor the development of the cyst and hence make them fertile.

Conclusions

The present study disclosed that high prevalence of camel CE with a higher proportion of fertile and viable cysts indicating a serious public health concern particularly in the study areas. Therefore, timely efforts should be made to control the transmission of cystic echinococcosis through extension work on safe disposal of infected offal and dead animals, awareness creation to the community about the disease, construction of abattoirs with appropriate disposal pits and introducing strict meat inspection protocols. Moreover, molecular based study should be conducted to identify the prevailing strains/genotype of *E. granulosus* in the area.

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Conflict of interest

The authors declare that they have no competing interests. This piece of work has not been published previously or not submitted for publication elsewhere. The submission is approved by all authors and all the authors declare that they have no conflict of interest.

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