European Journal of Applied Sciences 5 (1): 12-18, 2013
ISSN 2079-2077

DOI: 10.5829/idosi.ejas.2013.5.1.66102

# Mprevalence and Financial Loss Estimation of Cystic Echinococcosis in Cattle Slaughtered at Mizan Teferi and Teppi Municipal Abattoirs, South-Western Ethiopia

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**Abstract:** A cross-sectional study to determine the prevalence and estimate financial losses due to hydatidosis in cattle slaughtered at Mizan Teferi and Teppi abattoirs was carried out from October 2010 to April 2011. Out of the total 382 cattle slaughtered and examined visually and manually (palpation and incision), 43 (11.26%) were infected with hydatid cysts, harboring one or more cysts in different visceral organs (lung, liver and kidney). Only body condition had shown a significant association with regard to cyst detection ($P<0.05$). Out of 43 infections detected from different organs, 26 (60.47%), 14 (32.56%) and 3 (6.98%) were found from the lung, liver and kidney respectively. On the other hand, size category of cysts indicated that 16 (37.2%) were small, 12 (27.9%) medium and 15 (34.9%) large. No detectable cysts were found in the heart and spleen. Of the 43 hydatid cysts collected and examined for the status of fertility, sterility or calcification, 13 (28.9%) were fertile, 21 (46.67%) sterile and 11(24.4%) calcified. And out of 13 fertile cysts, 6(13.3%) were viable and 7(15.56%) were non viable. In the current study, the annual economic loss due to bovine hydatidosis at Mizan Teferi and Teppi municipal abattoirs due to offal condemnation and carcass weight loss was assessed and estimated at 127,456.3 ETB (7,497.43 US$; 1US$= 17 ETB). Considering the current result, hydatidosis is occurring in a moderate frequency in those areas supplying cattle for slaughter at Mizan Teferi and Teppi municipal abattoirs than it has been encountered elsewhere in Ethiopia. However, there seems an existing socio-economic situation favourable for hydatidosis and hence the issue should not be undermined. For that reason, it remains one of the most important diseases warranting serious attention for prevention and control actions in Mizan Teferi and Teppi areas. Thus, establishment of well equipped standardized abattoirs, creation of public awareness and control of stray dogs are paramount importance.

**Key words:** Abattoir % Hydatidosis % Cattle % Financial Loss % Mizan Teferi % Teppi

## INTRODUCTION

The economy of Ethiopia is based on agricultural sector which contributes to 40-50% of the Gross Domestic Product (GDP), over 90% of the foreign exchange earnings and about 85-90% of the employment opportunities in the country. Majority of the agricultural output is generated from crop and livestock integrated production systems. The livestock sub sector alone contributes to 12% of the total and over 45% of the agricultural GDPs. Over 85% and 90% of the farm and pastoral incomes, respectively, are generated by or from livestock. Ethiopian livestock population has reached to 52 million cattle, 33 million sheep, 30 million goats and 2.5 million camels and it is the largest in Africa. However, the contribution from this huge livestock resource to the national income is disproportionately small, owing to several factors. Diseases are among the factors responsible for poor production and productivity [1].

Cystic echinococcosis (hydatidosis) is a zoonotic parasitic infection of many mammalian species caused by the larvae of *Echinococcus granulosus*, which is found in the small intestines of dogs and other carnivores [2]. It occurs throughout the world and causes considerable economic losses and public health problems in many countries [3, 4]. Its distribution is higher in developing countries especially in rural communities where there is close contact between dogs (definitive host) and various

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domestic animals which may act as intermediate hosts [4]. The main hydatid induced losses in ruminants are productivity losses (reduction in carcass weight, milk production and fleece value), losses of offal (liver, lung, kidney and heart) and fertility losses [5, 6].

Ethiopia has been noted for a high prevalence of hydatid disease since 1970s [7] during which it was reported that it occurs "time and again" in all parts of the country. Fuller and Fuller [8] documented a hyperendemic focus of hydatid disease in south-western Ethiopia in Dassanetch and Nyangatom people after clinical and serological tests in various regions of the country. Moreover, reports of findings from abattoirs in various locations revealed that hydatidosis is widespread in Ethiopia with great economic and public health significance [9-12]. In view of the economic significance due to hydatidosis in Ethiopia, significant degrees of monetary losses ranging from 25,608 to 410.755.90 Ethiopian Birr (or 1,506.35 to 24,164.11 USD) were reported from various parts of the country [13- 18]. Yet, information available with respect to the occurrence and financial loss evaluation due to hydatidosis in areas around Mizan Teferi and Teppi in south-western part of the country seems to be scarce. Therefore, the current study is aimed at estimating the prevalence and assesses the financial loss due to hydatidosis in cattle slaughtered at Mizan Teferi and Teppi municipal abattoirs in south-western Ethiopia.

## MATERIALS AND METHODS

**Study Area:** The study was conducted at Mizan Teferi and Teppi municipal abattoirs, which are found in Bench Maji and Sheka zones, Western Ethiopia. Bench Maji lies between 5°33' to 7° 21' N latitude and 34°88' to 36°14' E longitude and the altitude ranges between 500 to 2500 meters above sea level (masl). It has an area of 19,965.80 $km^2$ and human population of about 475,902 of which 89.8% live in the rural area. Mizan Teferi, the capital of Bench Maji zone is situated at about 561km away from Addis Ababa to the southwest of the country. The livestock population of the zone comprises of 778,056 cattle, 112,793 sheep, 91,939 goats, 12,559 horses and 1,035 donkeys [19]. Agro-ecologically, the zone is divided into lowland (50%), midland (45%) and highland (5%). The average annual rainfall ranges from 400 to 2000mm and the mean annual temperature ranges between 15°c to 27°c. The zone has a land use pattern where about 35,761 hectares (ha) covered by perennial crops, 13,8917 ha annual crops, 55,0308 ha forest cover, 33,5030 ha bush land, 7,924 ha grassland, 478,269 ha unused suitable land, 135,000 ha unsuitable land 18,0126ha reserved for parks and other purposes [20]. Most features are similar to Bench Maji area description. Teppi town lies at an average altitude of 1400m above sea level and receives a mean annual rainfall of 1533.94 mm.

**Study Animals:** The study animals were selected from cattle slaughtered at Mizan Teferi and Teppi municipal abattoirs from October to May 2011. These animals were originated from different districts of Bench Maji zone and two districts of Keffa zone (i.e. Gesha and Chena). All the animals brought to the abattoir for slaughter were local zebu, adult in age and only male. After arrival, the age of animals was estimated as described by Turton [21].

**Study Design:** A cross-sectional study was conducted to estimate the prevalence, cyst characteristics and financial impact of bovine hydatidosis at Mizan Teferi and Teppi municipal abattoirs. Three days out of five slaughtering days per week were randomly selected to visit abattoirs and on the selected dates all slaughtered cattle were examined.

**Sample Size Determination and Sampling Technique:** The sample size was calculated according to Thrusfield [22] by considering 35% expected prevalence and 95% confidence interval with a 5% desired absolute precision. Hence, a total of 382 cattle were examined in both abattoirs.

**Post Mortem Examination and Sample Collection:** During antemortem examination origin, age and body condition of individual animals were recorded. The study animals, depending on their body condition were ranked as fat and medium as described by Nicholson and Butterworth [23]. All the animals were identified on the basis of markings on the body surface using paint brush and ink and these markings were transferred to all visceral organs during post-mortem inspection. Following slaughter post-mortem examinations were thoroughly carried out according to procedures recommended by FAO/UNEP/WHO [24]. The size (diameter in centimetres) of individual cysts was measured and recorded. The cysts were randomly selected and collected from different organs were taken to Mizan regional Veterinary Laboratory and examined for fertility and viability according to Macpherson *et al*. [25]. According to their size, hydatid cysts were classified as small (< 4cm), medium (4-8cm) and large (above 8cm in diameter) [26].

**Estimation of Financial Loss:** Annual financial loss due to hydatidosis in cattle slaughtered at abattoirs was estimated by considering the mean costs of organs condemned (losses of offal ($L_{offal}$)) and carcass weight loss (meat production losses) due to the disease ($L_{meat}$) [5]. The mean prices of respective organs and information on the mean retail market cost of 1 kilogram beef at Mizan Teferi and Teppi towns were obtained from butchers. Likewise, the annual slaughter rates were estimated from retrospective abattoir record of the last three years (2007/08-2009/10). The average mature body weight for Abyssinian short horned zebu is about 300kg (Payne and Hodges, [27] and the average dressing percentage for *B. indicus* ranges from 50-55% (nearly 53%) [28]. Accordingly, the mean carcass weight (dressing percentage) (kg/head) for zebu considered in this calculation was 159. Moreover, reduction in carcass weight due to hydatidosis was calculated as 3.75% of mean carcass weight [29]. According to Sariozkan and Yalcin [5], the financial loss due to hydatidosis considering losses of offal ($L_{offal}$) and meat production loss ($L_{meat}$) could be determined as:

$$\text{Annual loss} = \text{Losses of offal } (L_{offal}) + \text{meat production losses } (L_{meat})$$

where:

- Losses of offal ($L_{offal}$) = [((mean number of slaughtered animals x CE prevalence) x price of condemned offal per infected animal)]. This could be expressed in detail as:

$$L_{offal} = [(mNAS \times P_{CE} \times Plu \times Cplu) + (mNAS \times P_{CE} \times Phr \times Cphr) + (mNAS \times P_{CE} \times Pli \times Cpli) + (mNAS \times P_{CE} \times Psp \times Cpsp) + (mNAS \times P_{CE} \times Pkid \times Cpkid)]$$

where:

$L_{offal}$ : Loss due to offal condemnation
mNAS : Annual mean number of cattle slaughtered
$P_{CE}$ : Prevalence of hydatidosis
Plu : Percent involvement of lung
Cplu : Current mean retail price of lung
Phr : Percent involvement of heart
Cphr : Current mean retail price of heart
Pli : Percent involvement of liver
Cpli : Current mean retail price of liver
Psp : Percent involvement of spleen
Cpsp : Current mean retail price of spleen
Pkid : Percent involvement of kidney
Cpkid : Current mean retail price of kidney

- Meat production losses ($L_{meat}$) = [(((mean number of slaughtered animals x CE prevalence) x percentage reduction in the mean carcass weight) x Current price of meat/Kg)] as described by Sariozkan and Yalcin [5] using the following computation:

$$L_{meat} = [(((mNAS \times P_{CE} \times 3.75\%) \times 159 \text{ kg}) \times CPb)]$$

where:

$L_{meat}$ : Meat production losses
mNAS : Mean number of cattle slaughtered annually
$P_{CE}$ : Prevalence of hydatidosis
Cpb : Current mean price of 1kg beef at Mizan Teferi and Teppi towns.
159 kg : Mean carcass weight (dressing percentage) for adult Zebu [28].
3.75% : Reduction in mean carcass weight due to hydatidosis [29]

**Data Management and Analysis:** All collected data were entered into Microsoft Excel spread sheet and coded. Then it was summarized by using descriptive statistics like percentages and proportions. Chi-square test was used to analyze the association of the hypothesized risk factors and the prevalence of cystic echinococcosis. For this analysis STATA version 11 (Stata Corp. College Station, TX) data analysis software was employed.

## RESULTS

**Overall Prevalence:** Out of the total of 382 cattle slaughtered and examined, 43 (11.26%) were infected with hydatid cysts, harbouring one or more cysts in different visceral organs. The detailed analysis of the occurrence of hydatidosis and the considered risk factors showed on Table 1.

**Size and Organ Distribution of Hydatid Cysts:** Out of 43 infections detected from different organs, 26/43 (60.47%), 14/43 (32.56%) and 3/43 (6.98%) were found from the lung, liver and kidney respectively. On the other hand, size category of cysts indicated that 16/43 (37.2%) were small, 12/43 (27.9%) medium and 15/43 (34.9%) large. No cysts were detected in the heart and spleen (Table 2).

**Cyst Status Characterization:** Of the 45 hydatid cysts collected and examined for the status of fertility, sterility or calcification, 13/45 (28.9%) were fertile, 21/45

Table 1: Prevalence and risk factors association of hydatid cysts in cattle slaughtered at Mizan Teferi and Teppi municipal abattoirs

| Risk factors | Number examined | Number infected | Relative prevalence (%) | 95% CI | $P^2$ | P-value |
|---|---|---|---|---|---|---|
| Origin | | | | | | |
| Bench | 198 | 21 | 10.6 | 6.28 - 14.9 | | |
| Chena | 75 | 8 | 10.7 | 3.50 - 17.8 | | |
| Gesha | 109 | 14 | 12.8 | 6.50 - 19.2 | 0.385 | 0.825 |
| Age | | | | | | |
| < 5 year | 125 | 10 | 8 | 3.18 - 12.8 | | |
| > 5 year | 257 | 33 | 12.8 | 8.7 - 16.9 | 1.97 | 0.16 |
| Body condition | | | | | | |
| Medium | 174 | 32 | 18.4 | 12.58 - 24.2 | 16.28 | 0.000 |
| Fat | 208 | 11 | 5.3 | 2.22 - 8.4 | | |
| Over all | 382 | 43 | 11.3 | 8.07 - 14.44 | | |

CI: confidence interval

Table 2: Size and organ distribution of hydatid cysts at Mizan Teferi and Teppi municipal abattoir

| | Organ inspected | | | | | |
|---|---|---|---|---|---|---|
| Cyst size | Lung | Liver | Kidney | Spleen | Heart | Total (%) |
| Small | 4(15.4%) | 9(64.3%) | 3(100%) | - | - | 16(37.2%) |
| Medium | 9(34.6%) | 3(21.4%) | - | - | - | 12(27.9%) |
| Large | 13(50%) | 2(14.3%) | - | - | - | 15(34.9%) |
| Total | 26(60.47) | 14(32.6%) | 3(6.98%) | - | - | 43(100%) |

Table 3: Status of cysts on different organs

| | Fertile | | | | |
|---|---|---|---|---|---|
| Organ | Viable (%) | Non viable (%) | Sterile (%) | Calcified (%) | Total |
| Lung | 5(11.1%) | 5(11.1%) | 15(33.3%) | 3 (6.67%) | 28 (62.2%) |
| Liver | 1(2.2%) | 2(4.4%) | 4(8.89%) | 7 (15.56%) | 14 (31.1%) |
| Kidney | - | - | 2(4.4%) | 1 (2.2%) | 3 (6.67%) |
| Total | 6 (13.3%) | 7 (15.56%) | 21 (46.67%) | 11 (24.4%) | 45 (100%) |

(46.67%) sterile and 11/45(24.4%) calcified (Table 3). And out of 13 fertile cysts, 6/45 (13.3) were viable and 7/45 (15.56%) were non viable.

## Financial Loss Estimation

**Loss Due to Organ Condemnation ($L_{offal}$):** In the current study, a total of 26 lungs, 14 livers and 3 kidneys were condemned due to detection of hydatid cysts. The mean current unit prices of these organs in Mizan Teferi and Teppi towns were 10, 60 and 10 Ethiopian Birr (ETB) respectively whilst the mean current price of 1kg beef was 40 ETB during the study period. Mean number of animals slaughtered annually (mNAS) at Mizan Teferi and Teppi municipal abattoirs were determined from a three year records as 4275. In view of that, the annual economic loss due to offal condemnation ($L_{offal}$) is calculated as:

$L_{offal}$ = $(mNAS \times P_{CE} \times plu \times Cplu) + (mNAS \times P_{CE} \times Pli \times Cpli) + (mNAS \times P_{CE} \times Pkid \times Cpkid)$ = (4275 x 0.1126 x 0.6047 x 10) + (4275 x 0.1126 x 0.3256 x 60) + (4275 x 0.1126 x 0.0698 x 10) = 2910.81 + 9403.95 + 335.99 = 12,650.75

*Meat production Loss* ($L_{meat}$)

$L_{meat}$ = (mNAS x $P_{CE}$ x 3.75% x159xCPb) = 4275 x 0.1126 x 0.0375 x 159 x 40 = 114,805.55 ETB

Total loss = loss of offal ($L_{offal}$) + meat production losses ($L_{meat}$) = 12,650.75+ 114,805.55 = 127,456.3 ETB (7,497.43 US$, 1US$= 17 ETB)

## DISCUSSION

This study revealed that the prevalence of hydatidosis in cattle slaughtered at Mizan Teferi and Teppi municipal abattoirs was 11.26%. This result is comparable to that reported as 15.4% [14], 16.85% [17] and 16% [30]. However, it is lower than the findings from most places in Ethiopia like 32.1% in Mekele [11], 22% in Tigray [13], 48.9% in Debre Markos [15], 61% in Assela [31] and 52.69% in Hawassa [32]. Such a variation could be attributed to factors like difference in culture, social activities, animal husbandry system, lack of proper removal of infectious carcass and attitude to dogs in different regions [33]. Likewise, there seems a tendency

towards preferring to good looking animals for slaughter than including emaciated animals which might have led to avoidance of infections in lean animals from being detected. Poor or lean body conditioned animals are often unfit for slaughter and not included; and hence their status could not be recognized. This was a common phenomenon in the study area and it could have contributed to detection of fewer infections.

Yet a significant variation was observed in the rates of infection as per body condition score ($P< 0.05$) where medium body conditioned animals were more infected than fat. This is in agreement to Polydorou [29] that in moderate to severe infections, the parasite may cause retarded performance and growth, reduced quality of the meat and milk, as well as live weight loss. This work has also shown that hydatid cysts occurred almost commonly in the lung (60.4%) followed by the liver (32.56%). This is consistent to the fact that cattle are slaughtered at older age, during which period the liver capillaries are dilated and most oncospheres pass directly to the lung; additionally, it is possible for the hexacanth embryo to enter the lymphatic circulation and be carried via the thoracic duct to the heart and lung in such a way that the lung may be infected before or instead of liver [34].

Hydatid cyst condition tended to follow size dependent pattern in that most of the small cysts were calcified. This can be due to the host defence mechanisms of killing more efficiently with parasitic larvae at early stage of development [35]. Lung harboured a higher frequency of large and medium sized cysts, where as liver was found to harbour a higher number of small sized and calcified cysts. This fact can be stated that the relatively softer consistency of lungs allowed easier development of the pressure of cysts [36]. The higher number of calcified cysts in the liver could be attributed to relatively higher reticulo-endothelial cells and abundant connective tissue reaction of the organs. Likewise, the high amount of small cysts may be due to immunological response of the host, which might prohibit expansion of cyst size [34]. In investigating the condition of cyst fertility and viability, the overall percentage of fertile cysts in this study was 30.2%. This is in agreement with the finding of Bekele and Butako [17] where a 30.6% fertility of hydatid cysts were detected in cattle slaughtered at Wolayita Sodo municipal abattoir, but slightly higher than the finding of Regassa *et al*. [32] where a 26.9% fertility of hydatid cysts were detected in cattle slaughtered at Hawassa municipal abattoir. In comparison of the fertility rates of cysts among the organs, it was higher in the lungs (76.9%) than in the liver (23.1%). It has been stated that the relatively softer consistency of lung tissue allows the easier development of the cysts and the fertility rate of hydatid cysts may show a tendency to increase with advancing age of the host [35]. This may be attributed probably due to reduced immunological capability of the animals at their older age of infection. The variation between tissue resistances of the infected organ may also influence the fertility rate of hydatid cysts. This study also revealed that higher proportion of the cysts is sterile (48.8%) and calcified (25.6%). This is in agreement to Thompson *et al.* [37] who reported that most of the cysts in cattle were sterile.

In the current study, the annual financial loss due to bovine hydatidosis at Mizan and Teppi municipal abattoirs from offal condemnation and carcass weight loss was assessed and estimated at 127,456.3 ETB (7,497.43 US$; 1US$= 17 ETB). The current estimate is higher than the annual loss estimated at Tigray abattoir that is 2,807.89 US$ [13] and 5869.8US$ [16] in Adama. But, is lower than 51,883US$ [15], 30,202.64 US$ [17] and 131,737.19 US$ [32] at Debre-Markos, Wolaita Sodo and Hawassa respectively. The difference in financial loss analysis in various abattoirs or regions may be due to the variation in the prevalence of the disease, mean annual number of cattle slaughtered in different abattoirs and variation in the retail market price of organs or price of a kilo of beef in different places.

In conclusion, this study shows that the prevalence of hydatidosis in areas supplying cattle for slaughter at Mizan Teferi and Teppi municipal abattoirs is moderate. However, the occurrence of the disease in the area is most likely greater than the current detection since it was difficult to recognize the status of infections in lean cattle as they are excluded from abattoirs. This implies that the disease causes high degree of financial loss annually. The liver and lung were the most frequently affected and condemned organs at abattoirs, which contributes more to the monetary loss as the consequence of the disease. In addition, loss incurred due to disease could impact to losses like impaired productivity, such as reduced traction power of oxen, reduced milk production, retarded growth rate and related manifestations.

Hence, backyard slaughtering of animals should be prohibited via designing and reinforcing of legislation, construction of slaughter house which fulfils the necessary facilities and implementation of proper meat inspection. All condemned organs should be properly disposed, stray dogs must be prohibited from abattoir and get access to infected offal. Immediate attention should be

given to the safe and controlled elimination of all condemned abattoir materials and the sale of infected and contaminated offal as good feed should be avoided. Public education about the disease should be carried out at schools and adult people via films, pamphlets, radio broadcasts and direct information to farmers by public health officers and veterinary personnel. Awareness creation program should be launched for the butchers; abattoir workers and dog owners on the issue of the danger of hydatidosis to human and animals.

## ACKNOWLEDGEMENTS

The authors would like to express their special thanks to the staff members of Mizan Teferi and Teppi municipal abattoirs and the staff members of Mizan Teferi regional veterinary laboratory for all sorts of assistance.

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