

A close-up photograph of a zebra's head and neck, showing its characteristic black and white stripes. The zebra is grazing on green grass in a field. The image is framed with rounded corners.

Journal of Veterinary Medicine and Animal Health

Volume 6 Number 1 January, 2015

ISSN 2141-2529



*Academic
Journals*

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Jeju National University
Jeju city
Jeju 690 756
South Korea

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Full Length Research Paper

Epidemiological study on poultry coccidiosis: Prevalence, species identification and post mortem lesions in grower chicken in Kombolcha, North-Eastern Ethiopia

Bereket Molla^{1,2*} and Abdu Ali¹

¹School of Veterinary Medicine, Wollo University, Dessie, Ethiopia.

²The Donkey Sanctuary Ethiopia, SNNPR Project, Hawassa, Ethiopia.

Received 6 November, 2014; Accepted 10 December, 2014

A cross sectional study was conducted in Kombolcha Poultry Farm Enterprise to determine the prevalence, assessment of the risk factors and to identify the pathological abnormalities due to different species of *Eimeria* in 582 chickens of age 21 to 100 days, kept under deep litter management system from December, 2013 to March, 2014. The study involved fecal examination, post mortem examination, gross lesion examination, mucosal scraping examination and identification of *Eimeria* species. A statistically significant difference ($p=0.000$) was noted among the different age groups of grower chickens with the highest prevalence (73.1%) at 91 to 100 days old age group and the lowest (10.3%) in 21 to 30 days old age group. Out of 90 chicken subjected for post mortem examination, 58% ($n=52$) have showed gross pathological lesions in different parts of intestine. Gross lesions recorded were higher in Kookook breed (62.1%); however, there was no statistically significant difference among breeds. There was a statistically significant difference ($p=0.011$) in different age groups for gross lesion and it was high (71.4%) in 81 to 90 days old chickens and lower (22.2%) in 21 to 30 days old. Five *Eimeria* spp. were identified with *Eimeria brunetti* and *Eimeria tenella* which recorded most frequently prevalence of 17.8 and 12.2%, respectively, as single infections. Finally, it is concluded that the risk factors that are associated with coccidiosis should be taken into account in designing the prevention and control regimen. It was advised to design and implement strategic prophylaxis against coccidiosis than therapeutic approach, and conduct continuous coccidiosis monitoring via regular litter oocyst counts and taking appropriate measures accordingly.

Key words: Coccidiosis, *Eimeria* species, Ethiopia, Kombolcha, poultry, prevalence.

INTRODUCTION

Ethiopia has estimated poultry of 42 million (CSA, 2010)

accounted to be 60% of the total chicken population of

*Corresponding author. E-mail: mollabereket@gmail.com.

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East Africa, playing significant role in human nutrition, and as source of income (Mekonnen et al., 1991). Poultry production in Ethiopia is categorized into traditional, small and large-scale orientated sectors, which is based on the objective of the producer, the type of inputs used, and the number and types of chickens kept (Alemu, 1995). The rural poultry sector constitutes about 99% of the total chicken population and managed under the traditional village poultry production systems (Tadelle et al., 2003).

One of the main constraints for the development of commercial poultry production is development of disease conditions (Alamargot, 1987), which can have devastating effects particularly on intensive production. Indeed, commercial poultry consist of exotic birds selected for their capacities in producing eggs and meat; and because of this selection, these animal are much more susceptible to diseases than the traditional backyard poultry (CIRAD, 2005).

Different diseases have been diagnosed or suspected in commercial poultry in Ethiopia, leading to economic loss and these are Newcastle disease, coccidiosis, salmonellosis, chronic respiratory disease and nutritional deficiencies (Alamargot, 1987; Nasser, 1998). But there is little information about the prevalence of these diseases and their direct impact on poultry production (CIRAD, 2005). Coccidiosis is endemic in Ethiopia, causing great economic losses, particularly in young growing birds, in different production systems (FAO/LIRI, 1995). For example, in deep-litter intensive system, prevalence rates of 50.8% (Fessessework, 1990), 48.2% (Methusela, 2001), and 38.34% (Lobago et al., 2005) were reported in Debrezeit and its surroundings, Debrezeit and Addis Ababa, and Kombolcha, respectively. Apart from causing disease and losses, sub-clinical infections (mild infections without showing symptoms) cause reduced feed conversion. Since feed expenses form some 70% of the cost of producing broiler chickens, the economic impact of coccidiosis can be immense (Jordan et al., 2002; Vegad, 2004).

Quantitative losses due to coccidiosis in Ethiopia are not well documented, but Methusela (2001) and Methusela et al. (2004) have reported that coccidiosis contributes to 8.4 and 11.86% loss in profit in large and small scale farms, respectively.

Coccidiosis still continues to be one of the most economically important, but still wide spread disease of poultry in spite of advances made in prevention and control through immunomodulation, chemotherapy, management, nutrition (Graat et al., 1996; Pangasa and Singla, 2007) and genetic selection (Jordan et al., 2002; Vegad, 2004).

The epidemiology of coccidiosis is a timely issue to be established for determining the potential risk factors and species causing the diseases, and subsequent design of prevention production system, agro-ecology and level of and control regimen, which is suiting the local

management (Sandhu et al., 2009).

Kombolcha Poultry Farm Enterprise has introduced Kookook, Isabrown and Lohman breeds for multiplication, evaluation and dissemination to different level of producers in semi-intensive and backyard poultry production systems in Ethiopia. Therefore, this research was conducted to address coccidiosis in Kombolcha Poultry Farm Enterprise with the following objectives.

- (1) To determine the prevalence of poultry coccidiosis
- (2) To assess the risk factors associated with the disease
- (3) To determine different species of *Eimeria* causing coccidiosis in the farm, and
- (4) To assess the pathological abnormalities due to different species of *Eimeria* in poultry in Kookook, Isabrown and Lohman breeds.

MATERIALS AND METHODS

Study area

This study was conducted in Kombolcha Poultry Farm Enterprise, Kombolcha, South Wollo, North-Eastern Ethiopia, located 380 km North of Addis Ababa, the capital city. Kombolcha is at an altitude of 1864 m above sea level, situated at 11°7' N latitude and 39°44' E longitudes. The size of the farm is 7.5 hectare. The area has a bimodal rain fall, with a three year annual average rain fall of 1038 mm, annual mean temperature of 18°C and a relative humidity from 23.9 to 79% (ARARI, 2008).

Study population

The study was conducted from December 2013 to March 2014 on three breeds, Kookook, Lohman and Isa brown of chicken in Kombolcha. The first study group was out in dual purpose type Kookook breed having the age of 21 to 100 days. The study animals are grouped into breeds (Kookook, Lohman, and Isa brown) and age groups (21 to 30, 31 to 40, 41 to 50, 51 to 60, 61 to 70, 71 to 80, 81 to 90 and 91 to 100 days).

Housing and birds management

The Kombolcha Poultry Farm Enterprises is a deep litter large scale intensive poultry farm with 7.5 hectare land cover area. Currently, the farm has 13 functional poultry houses from which 6 were used for rearing of 20,212 grower chickens and the remaining 7 houses were for raising of parent stocks, during the study period. Four of the rearing houses have an area of 307 m² and the rest two houses have 207 m² each. Each of the four parent stock houses has an area of 350 m² and the remaining three houses have an area of 307 m². The farm has flock sizes ranging from 2180 to 4190 per rearing house and 1170 to 2000 per raising parent stock houses. Standard feeding with commercial available ration were followed.

The health management was based on prevention which comprised of vaccination, medication, bio-security and sanitation (cleaning and disinfection). In these farm vaccines, three types of diseases were given; these are Newcastle disease vaccine, which were given in three rounds at days 1, 18 and 42 of age. Gumboro (Infectious Bursal Disease) vaccination was also given in two rounds at 21st and 28th days of age. The third vaccine which was

given in the farm is fowl pox vaccine; given at 56 to 60 days old bird.

Anticoccidial drug (Amprolium 20% powder) was by 3 types of dosage system, 30 g per 100 L of drinking water, 60 g per 100 L of drinking water and 120 g per 100 L of drinking water for prevention, mild outbreak and severe outbreak, respectively, for 5 to 7 consecutive days (carried out twice in this study population). Antibiotics like oxytetracycline 20% powder, at a dosage of 0.5 g per 1 L of drinking water (for prevention) and 1 g per 1 L of drinking water (for treatment) was given for 5 to 7 consecutive days.

Sample size determination

The sample size was determined based on the formula recommended by Thrusfield (1995).

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

where n = sample size required, P_{exp} = expected prevalence, d = desired absolute precision.

Since the prevalence of coccidiosis in these breeds of chicken in Kombolcha Poultry Farm Enterprise had not been studied earlier, 50% expected prevalence rate was assumed. A 95% confidence interval and 5% desired absolute precision was used (Thrusfield, 2005). Though the calculated sample size was 384, to increase precision, it was strived to double the sample size, and a total of 582 birds were included in the study.

Study design and methods

Proportional number of birds from different breeds was randomly selected, and sampled for fecal examination. Birds at different age groups from each breeds of grower chicken were included in the sample to reach the required size for prevalence estimation. For gross lesion examination and species identification, birds were randomly selected from fecal sample positive birds whereby it was attempted to include different age groups in the samples.

Fecal examination

The selected birds were given identification number by permanent markers and kept separately in selection guard. The fecal samples were collected from the upper surface of the litter immediately after dropping of the feces by the selected bird. Then samples were processed in the laboratory immediately and oocyst examination was done. After fecal examination, there was an observation of chickens found in the selection guard and some selected chickens coprologically positive were subjected for post mortem examination. During sampling for post mortem examination age and breed were considered as factor of interest. Oocysts in each faecal sample of chicken were detected by using flotation technique using saturated Sodium Chloride Solution (MAFF, 1982; Conway and McKenzie, 2007).

Post mortem examination

Post mortem examinations on selected coprologically positive chickens were conducted following the procedure by Long and Reid (1982) and Conway and McKenzie (1991, 2007). After selecting the sample of chickens from coprologically positive chickens, they were transported to postmortem room in the farm. Chickens were sacrificed by cervical dislocation using the technique by Zander

(1991). The examination was performed on a daily basis and the finding (major gross lesions associated with coccidiosis) of each age group were registered.

Gross lesion examination

Examination of the serosal surface of unopened intestines for lesions was done after being freed from mesentery. After opening of intestine with scissors, extending from the duodenum to the rectum, including caecum, all intestinal walls were examined for gross pathological changes. The intestinal portions were divided into five sections, the duodenum, jejunum, mid intestine (above and below the yolk sac diverticulum), the lower part (distal ileum and rectum) and caecum. The lesions were considered positive when there was a minor to major abnormalities like (enlargement, petechia, reddening, thickening, ballooning, hemorrhage (bleeding), caecal core, whitish spot), and were considered negative when there were no gross abnormalities.

Mucosal scraping examination

Small scraps were taken from different segments of intestine and put on the slide and diluted with saline then covered with cover slip and examined under microscope first with (10x magnification and proceeded to 40x magnification) appropriate light and recorded oocyst shape and size of oocyst by using micrometer.

Eimeria species identification

Identification of *Eimeria* spp. was based on the combination of observations on the nature of gross pathological lesions, the site of infection, and the size and shape of the oocyst according to Long and Reid (1982), key for coccidia species identification.

Data analysis

Data was entered and managed in Microsoft Excel worksheet and descriptive statistics was utilized to summarize the data. The data was analyzed using the latest version of SPSS 20 statistical software package. Pearson's Chi square test was used to measure statistical significance of results. In order to consider a result to be statistically significant, 95% CI and p-value < 0.05 was considered.

The point prevalence is calculated for all data by dividing positive samples by total number of examined samples and multiplied by hundred. The association between the prevalence of the disease and risk factors is assessed by Chi-square. A statically significant association between variables is considered to exist if the computed p-value is less than 0.05.

RESULTS

Prevalence of coccidiosis in different breeds, age groups and months of the year

From 582 fecal samples examined from three different breeds, the overall prevalence was 48.5% (n=282). Breed bases prevalence was 52.7, 35.0, and 42.0% in Kookook, Isabrown and Lohman, respectively (Table 1). There was statistically significant difference ($p = 0.005$) in the

Table 1. Breed and age level prevalence of coccidiosis in grower chickens which were collected in different months of the year.

Risk factor		No. of sample taken	No. of positive cases	Prevalence (%)
Breed	Kookook	402	212	52.7
	Isa brown	80	28	35.0
	Lohman	100	42	42.0
Total		582	282	48.5
Age	21-30	145	15	10.3
	31-40	80	32	40.0
	41-50	80	54	67.5
	51-60	103	65	63.1
	61-70	52	34	65.4
	71-80	45	28	62.2
	81-90	25	16	64.0
	91-100	52	38	73.1
Total		582	282	48.5
Months	December	173	88	50.9
	January	269	128	47.6
	February	60	24	40.0
	March	80	42	52.5
Total		582	282	48.5

In breed: $\chi^2 = 10.417$, df= 2; p value = 0.005; In age: $\chi^2 = 131.503$, df = 7; p value = 0.000; In month: $\chi^2 = 2.726$, df = 3; p value = 0.436.

prevalence of coccidiosis among different breeds.

The age level prevalence in 21 to 30, 31 to 40, 41 to 50, 51 to 60, 61 to 70, 71 to 80, 81 to 90, 91 to 100 days were 10.3, 40.0, 67.5, 63.1, 65.4, 62.2, 64.0, and 73.1%, respectively. The lowest coccidiosis cases were recorded at the age of 21 to 30 days, 10.3% and the highest numbers of coccidiosis cases (73.1%) were recorded at the age of 51 to 60 days (Table 1). The prevalence in different age groups was found to be statistically significant.

In this study, the samples were collected within four months of the year, from December to March. The highest prevalence of coccidiosis was recorded in March (52.5%) and the lowest prevalence was in February (40%) (Table 1), however, there was no statistically significant difference ($p = 0.436$) in prevalence among the months of the year.

Gross lesions occurrence in different breeds, age groups and months of the year

Post mortem examination revealed gross lesion in 58% (n = 52) of birds of three different breeds. The gross lesions commonly identified included enlargement, ballooning, hemorrhage, intestinal intussusceptions,

petechial hemorrhage, thickening, white spots and core (caecal). On breed bases, 62.1, 40.0 and 54.5% lesions were recorded in Kookook, Isa brown and Lohman, respectively (Table 2). There was no statistically significant difference ($p=0.221$) on occurrence of gross lesion among different breeds.

The age specific distribution of gross lesions were found to be 22.2, 56.3, 63.6, 58.8, 75, 50, 71.4 and 60% in 21 to 30, 31 to 40, 41 to 50, 51 to 60, 61 to 70, 71 to 80, 81 to 90, and 91 to 100 days of age groups, respectively. There was lowest lesion prevalence (22.2%) in age group 21 to 30 days and the highest (75%) in age group of 61 to 70 days (Table 2). There was no statistically significant difference ($p=0.11$) in the gross lesion occurrence in different age groups of birds.

The month bases distribution of gross lesions were 50, 65, 50 and 54.5% in December, January, February, and March months, respectively. There was statistically non-significant difference in the occurrence of gross lesion across the months of the year.

Eimeria species identified in different breed, age groups and months of the year

Five *Eimeria* spp.: *Eimeria acervulina*, *Eimeria maxima*,

Table 2. Occurrence of gross lesion in different breeds, ages and months of the year.

Risk factor		No. of sample taken	No. of lesion positive cases	Prevalence (%)
Breed	Kookkook	58	36	62.1
	Isa brown	10	4	40.0
	Lohman	22	12	54.5
Total		90	52	58
Age	21-30	9	2	22.2
	31-40	16	9	56.3
	41-50	22	14	63.6
	51-60	17	10	58.8
	61-70	8	6	75
	71-80	6	3	50
	81-90	7	5	71.4
	91-100	5	3	60
Total		90	52	58
Months	December	20	10	50
	January	40	26	65
	February	8	4	50
	March	22	12	54.5
Total		90	52	58

In breed: $\chi^2=5.725$, df= 4; p value = 0.221; In age: $\chi^2=28.758$, df = 14; p value = 0.11.

Table 3. Distribution of different *Eimeria* species in different breeds.

Species of <i>Eimeria</i>	Frequency of <i>Eimeria</i> at different breeds			Total
	Kookkook	Isa brown	Lohman	
<i>E. acervulina</i>	5 (8.6)	1 (10)	1 (4.5)	7 (7.8)
<i>E. maxima</i>	4 (6.9)	0 (0.0)	2 (9.1)	6 (6.7)
<i>E. necatrix</i>	7 (12.1)	1 (10)	1 (4.5)	9 (9.7)
<i>E. tenella</i>	8 (13.4)	1 (10)	2 (9.1)	11 (12.2)
<i>E. brunetti</i>	11 (19)	2 (20)	3 (13.6)	16 (17.8)
<i>E. acervulina</i> + <i>E. maxima</i>	3 (5.2)	0 (0.0)	2 (9.1)	5 (5.6)
<i>E. tenella</i> + <i>E. acervulina</i>	4 (6.9)	1 (10)	2 (9.1)	7 (7.8)
<i>E. tenella</i> + <i>E. brunetti</i>	10 (17.2)	2 (20)	6 (27.3)	18 (20)
<i>E. tenella</i> + <i>E. necatrix</i>	6 (10.3)	2 (20)	3 (13.6)	11 (12.2)
Total	58 (64.4)	10 (11.1)	22 (24.4)	90 (100)

Breed level: $\chi^2=10.382$, df =18; p value = 0.919.

Eimeria necatrix, *Eimeria tenella*, and *Eimeria brunetti* were identified as single and/or mixed infections, due to *E. tenella* co-infection with other species, with prevalence as shown in Table 3.

Single infection occurrence recorded was 54.4% (n = 49) and mixed infections for 45.6% (n = 41) of the total infection from the total of 90. The distribution of *Eimeria* spp. on different breeds of chickens was found to be

statistically non-significant (p=0.919), although the distribution was higher in Kookkook breed (64.4%), and lower in Isa brown breed (11.1%) (Table 3).

E. brunetti and *E. tenella* occurred most frequently with prevalence of 17.8 and 12.2%, respectively, as single infections, whereas the prevalence of *E. necatrix*, *E. acervulina* and *E. maxima* were found to be 9.7, 7.8 and 6.7%, respectively, as single infection (Table 3).

DISCUSSION

The results of this study showed that coccidiosis is still a major problem in Kombolcha Poultry Farm Enterprise, with overall prevalence of 48.5% ($n = 282$) in grower chickens of 21 to 100 days old. The highest numbers of coccidiosis cases (52.7%) were found in Kookook breed. The prevalence of coccidiosis in Kookook breed is significantly higher than the other two breeds ($p=0.005$). This finding is in line with the finding of Taylor et al. (2007) where the occurrence and incidence of the disease is also to a great extent affected by the type of chickens reared and breeds sensitivities to infection. The finding of this research is in agreement to previous reports in other parts of Ethiopia, where prevalence of 50.8% (Fessessework, 1990) and 48.2% (Methusela, 2001) were recorded in deep litter system of management. In contrast, the 48.5% prevalence of this study is higher as compared to the previous study done in the same area reported; 38.34% (Lobago et al., 2005), 22.3% (Abadi et al., 2012) in age of 1 to 60 days of dead RIR and WLH chickens, respectively.

The high prevalence of coccidiosis in this study may be ascribed mainly to the age group of birds which were sampled. That is, in the previous study, chickens age was from day 1 to 60, in which most of the time, the coccidia populations take time to build clinically significant levels where outbreaks usually occurs when birds are between 3 and 8 weeks of age (Fanatico, 2006). But, the study done by Abadi et al. (2012) included the lower age groups (1 to 20 days) which are rarely infected by coccidiosis; so, may decrease the overall prevalence of coccidiosis. The difference in prevalence in the current and previous study may also be due to breed difference, previous study had been done on WLH breed.

Another important factor which could lead to high prevalence was high stocking density (ranging from 16 to 18 birds/m²) at the poultry farm; but normally it should be between 10 and 15 birds/m² (Hamet et al., 1982). This finding was also in agreement to the production systems operating under high density conditions (that is, greater than 15 birds/m²) increases the risk of greater competition for feed and water, which there by increases litter contamination, buildup of oocysts and litter moisture (Hamet et al., 1982).

The prevalence of coccidiosis in different age groups was found to be statistically significant ($p<0.05$), with the highest being in 91 to 100 days (13 to 14 weeks). This finding was not in concordance with the findings of the other researchers (Methusela, 2001; Lobago et al., 2005; Abadi et al., 2012). This could be due to the vulnerability of the birds in the age group 91 to 100 days during the study period in the farm, due to irrational use of anticoccidial drugs.

On temporal bases, coccidiosis occurred higher in January (50%) and the lowest lesions were recorded in

February (7.7%). This is not in agreement to the survey of chicken coccidiosis; the monthly prevalence of *Eimeria* infection was higher in July (94.4%) compared to other months and June was the lowest (57.9%). This could be due to the local weather conditions and the management practices in the farm, and also, not all months of the year were assessed by the current study.

In the present study, 58% birds showed gross lesions, higher number of lesion being in Kookook breed (69.2%) and lower in Isa brown breed (7.7%), with no statistically significant difference. This variation may be due to high variation of number of sample taken from different breeds despite the fact that there could still be breed level variation. This should be further investigated.

The occurrence of gross lesion was the highest (26.9%) in the age of 41 to 50 days and the lowest (3.8%) in age of 21 to 30 days, with statistically significant difference among age groups. This finding is in agreement to Lobago et al. (2005) and Abadi et al. (2012), who reported that the age group between 41 and 50 days is the age at which the occurrence of coccidiosis is at peak.

In the current study, five *Eimeria* spp., *E. acervulina*, *E. maxima*, *E. necatrix*, *E. tenella*, and *E. brunetti* were identified. These species were also investigated by Abadi et al. (2012), in the same area. Age group 41 to 50 days (6 to 7 weeks) was the age group which showed the highest prevalence of overall distribution of *Eimeria* spp. (23.9%). This finding could be attributed to the fact that *E. tenella* infection which generally affects chickens below 10 weeks of age with maximum prevalence in 4 to 8 weeks old chicks (Mc Dougald, 2003); and it is rarely observed in the chickens below 2 weeks of age (Chauhan and Roy, 2008). The infection with *E. acervulina* and *E. maxima* are seen at 3 to 6 weeks of age and then *E. necatrix* at 8 to 18 weeks of age, whereas *E. brunetti* is seen both early and late (Mc Dougald, 2003).

The present study showed that *E. tenella* (34.1%) and *E. brunetti* (24.6%) occurred most frequently, with no statistically significant difference of species distribution with respect to age ($p=0.216$). This finding is not in agreement to previous reports in Ethiopia. *E. acervulina* was the most prevalent coccidial species (Ashenafi, 2000; Metusela, 2001; Dereje, 2002); and *E. brunetti* (45.3%) and *E. tenella* (40.8%), were found most frequently (Lobago et al., 2005). This variation could be due to the difference in breed of poultry or the different management systems of the study population.

Conclusion and recommendations

Coccidiosis is still a major problem in the Kombolcha Poultry Farm Enterprise, with increasing prevalence in grower chickens. Managerial problems such as high

stocking density, poor quality and management of the litter, leaking waterers, inadequate cleaning, the presence of birds of different ages and different breeds in a single house, the absence of vaccines and non-strategic prophylaxis against *Eimeria* were the main reasons and predisposing factors for the higher prevalence of clinical coccidiosis and occurrence of outbreak in the age between 90 and 100 days than the young ones in the farm.

The identified *Eimeria* species, causing coccidiosis in Kombolcha Poultry Farm Enterprise were *E. tenella*, *E. necatrix*, *E. brunetti*, *E. acervulina*, and *E. maxima*. This shows that all economically important *Eimeria* species are present and will continue to be a threat to the farm unless otherwise appropriate measure are taken.

Poultry coccidiosis is a major burden to poultry producers and veterinary health professionals from time to time by changing its mode of occurrence and with variation in the conditions of the different management system and level. Hence, poultry coccidiosis is demanding a lot of interventions and further research, to develop economical and sustainable prevention and control strategies. It has to be worked at least to bring it to acceptable level if not possible to get rid of it in Kombolcha poultry farm and other farms in the country.

Moreover, special attention should be given to the most susceptible age groups and breeds, as these are the potential risk factors associated with poultry coccidiosis, in order to minimize the losses associated with coccidiosis in poultry. The economical incursion by coccidiosis can be minimized through improving management level, which minimizes the predisposing factors at strategic time, will be effective mechanism particularly in intensive production system.

Therefore, based on the above conclusion the following recommendations are forwarded:

- (1) Management procedures which limit contamination of litter should be paid with high emphasis, keep litters dry through proper installation and management of watering systems.
- (2) Appropriate stocking density should be maintained and raising of multiple age and breeds in the same house should be avoided.
- (3) Strategic prophylaxis and treatment against *Eimeria* should be developed and implemented on the bases of the level of management in the farm, probably strategic inclusion of anticoccidials in diets or water should be sought for Kombolcha in specific.
- (4) Continuous coccidiosis/iasis monitoring should be conducted via regular monitoring of litter oocyst counts and appropriate measures should be taken accordingly.
- (5) Further research has to be conducted to assess natural relative resistance among different breeds in different management system to coccidiosis under natural infection, particularly at the young age groups

between Kookook, Isa brown and Lohman breeds.

(6) Vaccination against coccidiosis should be sought for in the future, particularly for highly susceptible breeds and in predisposing management systems with appropriate timing.

Conflict of interest

The authors declare that there is no conflict of interest.

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Full Length Research Paper

Determination of the presence and concentration of heavy metal in cattle hides singed in Nsukka abattoir

Kalu Ekenma^{1*}, Nwanta John Anelon² and Anaga Aruh Ottah³

¹Department of Veterinary Public Health and Preventive Medicine, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.

²Department of Veterinary Public Health and Preventive Medicine, University of Nigeria, Nsukka, Enugu State, Nigeria.

³Department of Veterinary Physiology and Pharmacology, University of Nigeria, Nsukka, Enugu State, Nigeria.

Received 11 February, 2014; Accepted 17 November, 2014

Due to the health related problems associated with eating red meat, cattle hides also known as *ponmo* or *kanda*, have become a substitute for red meat in Nigeria which in turn have resulted in the increase demand for this product. To meet this demand, abattoir workers do not take time in processing these hides appropriately as different substances are used to fuel the wood to hasten the process of singeing. Unfortunately, these substance deposits some toxic metals into the hides, which is capable of causing harm to its consumers. This study aims at investigating the heavy metal contamination of the hides singed in Nsukka slaughter slab due to the various substances used to singe the hides. Samples of singed and unsinged cattle hides were collected from the abattoir and analysed for cadmium (Cd), copper (Cu), iron (Fe), nickel (Ni) and lead (Pb) using Buck Scientific Atomic Absorption Spectrophotometer (AAS). Results showed that the mean concentrations of Pb, Cd, Fe, Cu, and Ni in unsinged hides were 5.65 ± 0.70 , 1.93 ± 0.39 , 9.88 ± 1.11 , 10.45 ± 1.19 and 1.95 ± 0.12 mg/kg, respectively. In singed hides, the mean concentrations of Pb, Cd, Fe, Cu, and Ni were 4.36 ± 0.79 , 1.48 ± 0.28 , 21.60 ± 3.52 , 12.77 ± 1.06 and 2.64 ± 0.21 mg/kg, respectively. The mean concentrations of the metals with the exception of Cu in both unsinged and singed hides were above the maximum permissible level set by World Health organization (WHO) and European Commission. The results of this study proved that the environment and singeing processes may be responsible for the heavy metal contamination of hides in Nsukka abattoir.

Key words: Heavy metals concentration, singeing, cattle hides, pollution, Nsukka abattoir.

INTRODUCTION

Abattoirs are one of the industries that contribute to the problem of possible food-borne diseases and potential health hazards associated with food; especially meat

(Nemerow and Dasgupta, 1991). The slaughter of livestock to produce meat and meat products is a widespread activity and can be an important industry in

*Corresponding author. E-mail: ekenmakalu2@gmail.com. Tel: 07033836939.

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many countries. The risk of heavy metal contamination in meat is of great concern for both food safety and human health, because of the toxic nature of these metals at relatively minute concentrations (Santhi et al., 2008).

Slaughtered ruminants such as goats, sheep and cattle are normally singed to get rid of the hair. Singeing is largely favored in many respects in African countries as it maintains the carcass hide for consumption and evokes flavors in meat that are highly acceptable by the local populace (Food and Agriculture Organization (FAO), 1985). These hides are prepared by singeing off the hair in flames fueled by substances such as wood mixed with engine oil, plastics mixed with refuse or tyres. Hides processed in this manner may contain toxic organic compounds such as polyaromatic hydrocarbons (PAH), dioxins, furans and benzene, heavy metals which can contaminate the hides (United States Environmental Protection Agency (US EPA), 1994; Agency for Toxic Substances and Disease Registry (ATSDR), 1998). Heavy metals are released during burning of hides with plastics, polystyrene polymers, tyres and woods fueled with engine oil (International Aquatic Fitness Conference (IAFC), 2000; Okiei et al., 2009). Free ranging animals as is the case in the traditional management of livestock in Nigeria can be good indicators of the general environmental pollution status (Tahvonen, 1996). Toxic trace metals can be transferred to these animals by respiration of polluted air, intake of feed or pasture contaminated with agricultural chemicals and vehicle emissions; and drinking of polluted water. These heavy metals bio-accumulate increasingly in organs and tissues of these animals (Tahvonen, 1996) and toxicity depends on dosage and length of time of exposure.

Reports have also shown that singeing of hides with hazardous substances could contaminate meat products and have adverse health implications (Okiei et al., 2009); in addition, the environment and meat processors are also at risk (Okiei et al., 2009; Holder et al., 1991). Continuous exposure and consumption of such potentially contaminated meat product poses a great source of health risk (Costa, 2000; Jayasekara et al., 1992; Leita et al., 1991). Water bodies located near the abattoir often get contaminated with these hazardous substances through bad abattoir practices, improper management and supervision of abattoir activities (Adelegan, 2002; Sangodoyin and Agbawe, 1992) including careless disposal of abattoir effluents (Sekabiru, 2010). Heavy metals such as copper, iron, chromium and nickel are essential metals since they play important roles in biological systems, whereas cadmium and lead are non essential metals but they are toxic, even in trace amounts (Fernandes et al.; 2008). Heavy metals are bioaccumulative and therefore require close monitoring (Bhattacharya et al., 2008). It is therefore imperative that this study be carried out.

The aim of this study was to investigate the possible heavy metal contamination of cattle hides singed with

wood fuelled with tyres, plastics and polystyrene materials in daily abattoir operations. The research also aimed at determining the heavy metal content of waste water gotten from washing of singed hides and its role in contamination of nearby water bodies and possible effects on aquatic life.

MATERIALS AND METHODS

Study area

The study area Nsukka urban in Enugu State, Nigeria, situated at latitude 6°45' and 7°N and longitude 7°12.5' and 7°36' E (Oformata, 1975). Nsukka is a university town with a population of 1.26 million (NPC, 2003). This abattoir is patronized on daily basis by this population and people within the environs for the purchase of meat and meat products.

Samples collection

A total number of 60 cattle (hides) were used for this experiment and were collected between the months of May to July, 2011. The veterinary approved slaughter point that was used was Nsukka Municipal Slaughter House, Nsukka, and Enugu North Senatorial Zone. Samples were collected from cattle skin immediately after flaying just before they were singed. The second sets of samples were collected after singeing of hides with wood fuelled with different substances. Ready to eat singed hides (singed – washed hides) were also used.

Processing of hides

After singeing the flayed hides, the abattoir workers soak these hides in a 208 L drum containing about 156 L of water (that is, about 3/4rd of the drum is filled with water) for about 10 to 20 min before washing them. An average of 6 hides is put into each drum. The waste water from the washing of these hides was also collected and analysed.

Sample analysis

Hides were collected directly from abattoir workers that singe them and were put in coolers containing some quantity of ice and carried to the laboratory. Each sample was scraped to remove ash and rinsed using distilled water. The samples were then drained and oven dried at 105°C for 4 h or until dried and homogenized using pestle and mortar until powdered. The powdered sample (1 g) was used for the wet digestion. This was put in a 50 ml volumetric flask. Five liters of concentrated acid mixture (HNO₃ and HClO₄) was added to the volumetric flask containing 1 g of powdered hide and shaken slightly to ensure proper mixture after which 5 ml of H₂SO₄ was also added and mixed gently. This mixture was then heated in a fume chamber for 30 min or until a clear solution was gotten. For samples in which solutions were not clear after digestion, acid solutions were added again and reheated. The flask was then left to cool and 20 ml of distilled water added to it. This mixture was shaken to ensure proper mixing. The volumetric flask was then filled to the 50 ml mark using distilled water. This was then analyzed using Atomic Absorption Spectrophotometer (AAS). The determinations were carried out in triplicates. Methods of wet digestion were adopted from Association of Official Analytical Chemist (1979) and Levinson (1968).

Statistical analyses for hide samples

The data on different variables obtained from the study were statistically analysed by using SPSS version 16 computer program. Analysis of variance and post hoc test were performed to find out the statistical differences among various parameters at $p < 0.05$. Correlation analysis was also computed to establish the relationships among various parameters (Steel et al., 1996). Ms Excel package was employed for graphical presentation of the data.

BIOASSAY

Brine shrimp lethality test (BSLT) using the singed effluents from hides to determine the LC₅₀

Water sample from washing of singed hides was collected using clean plastic containers free of debris. The water sample was analyzed with AAS. The sample was used at various dilution rates to determine the reaction of the aquatic shrimps with regards to mortality. Shrimps in distilled water were also monitored for comparison.

Determination of the concentration of the waste water effluent

The concentration of the water effluent was determined using a watch glass and a hot plate. The watch glass was weighed and recorded. The waste water (1 ml) sample was poured into the watch glass and placed on the hot plate and let to dry up. After the sample had dried to constant weight and let to cool, the weight of the watch glass was retaken and the difference between the two values was then taken and recorded as mg/ml.

Brine shrimp lethality testing (BSLT)

The method according to McLaughlin et al. (1991) was used to study the toxicity of waste water effluent. *Artemia salina* eggs obtained from a pet store in California USA were incubated in natural sea water (from the bar beach in Lagos, Nigeria) in a dam well under room condition. After 48 h, the cyst-like eggs hatched into nauplii/larvae. Ten shrimp nauplii (10) in 1 ml of autoclaved sea water were put into bijou bottles using pipette under a stereo microscope with a light source. They were separated into 4 groups of 3 each. Increasing concentration (73, 730 and 7300 ppm) of the sample was added to each group and distilled water was added to the control group. The nauplii were incubated at room temperature for 24 h after which the survivors in each group were counted.

Statistical analysis for BSLT

The results were analyzed using Finney's probit analysis (SPSS computer program) to determine the LC₅₀ at 95% confidence interval. Weak nauplii were noted as an indication of central nervous system (CNS) depression.

RESULTS AND DISCUSSION

The results from this study showed that the hides of cattle slaughtered in Nsukka abattoir accumulated varying levels of heavy metals. The mean concentrations of Cd, Cu, Fe, Ni and Pb in unsinged hides were 1.93 ± 0.39 , 10.45 ± 1.19 , 9.88 ± 1.11 , 1.95 ± 0.12 and 5.65 ± 0.70 mg/kg,

respectively.

The high concentration of heavy metals recorded in the unsinged hides may be attributed to the presence of heavy metals in the local environment which the animal could easily have come in contact with through scavenging in open waste or refuse dumps, free range grazing, drinking water from polluted streams and drains and exposure to atmospheric depositions especially from automobile fumes and open burning of solid waste (Obiri-Danso et al., 2008). These metals could also have come from various sources like vehicle emissions, tyre and engine wears, and agricultural chemicals, urban and industrial wastes (Okoye and Ugwu, 2010). Okoye and Ibeto (2008) reported high levels of lead and cadmium in soils from Enugu State which could serve as a source of heavy metals in animals grazing in such area of the state. Indeed, close correlation have been reported between heavy metals concentration in cattle tissues with that in soil, feed, and drinking water (Qiu et al., 2008).

In unsinged hides, the mean concentration of Cu and Pb were higher while Cd and Ni had lower values than those of previous studies (Table 2). Previous studies on the concentration of iron (Fe) in unsinged hides were not available when this study was carried out.

The mean concentrations of some of the metals: Pb, Cd and Cu from the present study were found to be higher than those obtained from previous works for singed treatment as shown in Table 2, while the values for Fe and Ni were lower. The differences in the concentrations of heavy metals in the various studies could be due to the different environmental factors, singeing techniques and rearing. All these values except for Cu were above the maximum permissible level set by WHO (1984) and European Commission Regulation in 2006. This report should be a source of concern on the public health implication of consumption of such hides. In singed hides, the mean concentrations of Cd, Cu, Fe, Ni and Pb were 1.48 ± 0.28 , 12.77 ± 1.06 , 21.60 ± 3.52 , and 2.64 ± 0.21 and 4.36 ± 0.79 mg/kg, respectively. Heavy metals were detected in all the samples analyzed. The mean concentrations of heavy metals determined in cattle hides are indicated as shown in Table 1. While the concentration of some metals increased, and others decreased.

Iron increased by 54.25% followed by Ni that increased by 35.38% and Cu that increased by 9.57%. Fe increased from 9.88 ± 1.11 to 21.60 ± 3.52 , Ni from 1.95 ± 0.12 to 2.64 ± 0.21 and Cu from 10.45 ± 1.19 to 12.77 ± 1.06 . The increase in the concentrations of Fe, Ni and Cu after singeing may be attributed to the fact that the hides were placed directly on metal stripes and rods or the type of substance used to wood fueled such as tyres, plastics or polyethen bags and spent engine oil, etc., as shown in Fig 1 and 2, it may also be linked to the fact the rate at which these metals are released from the substances used during the singeing process are different. The rate of intake of accumulation of these metals in the hides may

Table 1. Mean concentrations (mg/kg) of heavy metals in cattle hides in Nsukka slaughter house.

Heavy metals	USH (Mean±SEM)	SH (Mean±SEM)	SWH (Mean±SEM)	Maximum permissible level	
				EC (mg/kg)	WHO (mg/kg)
Lead	5.65±0.70 ^a	4.36±0.79 ^a	4.15±0.35 ^a	0.01	-
Cadmium	1.93±0.39 ^a	1.48±0.28 ^b	0.45±0.07 ^c	0.05	-
Iron	9.88±1.11 ^a	21.60±3.52 ^b	8.27±0.66 ^a	-	0.1*
Copper	10.45±1.19 ^a	12.77±1.06 ^a	6.08±0.56 ^b	20**	-
Nickel	1.95±0.12 ^a	2.64±0.21 ^b	2.24±0.23 ^a	0.05	-

USH: Unsinged hides, SH: singed hides, SWH: singed - washed hides, EC: European Commission, 2006; WHO: World Health Organization, 1984; * standard for Fe was set by WHO; **Values below MPL. Mean concentrations of metals within rows with different superscripts are statistically significant (post hoc test; P < 0.05).

Table 2. Comparison of the mean concentrations (mg/kg) of metals in the current study and previous studies.

Heavy metal	CS (Mean±SEM)	A (Mean±SEM)	B (Mean±SEM)	C (Mean±SEM)
Unsinged hide				
Lead	5.65±0.70	4.61±0.30	-	-
Cadmium	1.93±0.39	4.20±0.17*	-	-
Iron	9.88±1.11	NA	-	-
Copper	10.45±1.19	2.47±0.26	-	-
Nickel	1.95±0.12	3.50±0.17*	-	-
Singed hide				
Lead	4.36±0.79	3.06±0.26	16.35±21.28	NA
Cadmium	1.48±0.28	1.12±0.48	NA	NA
Iron	21.60±3.52	NA	46.40±10.61	206.40
Copper	12.77±1.06	5.67±1.24	11.35±3.18	NA
Nickel	2.64±0.21	2.63±0.12	NA	6.00

NA: Not Available, *Higher values in comparison to present study. Mean concentration are in mg/kg. CS: current study; A: Obiri-Danso et al. (2008); B: Okiei et al. (2009); Conc. in mg/dm³; C: Essumang et al. (2007).

hides may also be a contributing factor.

Singed treatment introduced greater concentration of Fe than any other metal by 54.25% compared to the unsinged and singed-washed. This may be attributed to the used engine oil that was constantly used to fuel the wood and/or that it occurs naturally in plants consumed by animals (Iwegbue et al., 2008). Ingestion of materials contaminated with Fe accounts for most of the toxic effects of Fe, because Fe is absorbed rapidly in the gastrointestinal tract.

It appears that the substantial heavy metal levels recorded in the unsinged hides contributed considerably to the overall values recorded with singed treatment in this study.

Lead (Pb) and Cd decrease by 22.83 and 23.32%, respectively. Singeing reduced the level of Pb by 22.83% from 5.65±0.70 in unsinged hides to 4.36±0.79 in singed hides which was not statistically significant (P = 0.198). The concentration of Cd decreased by 23.32% from 1.93±0.39 in unsinged hides to 1.48±0.28 in singed hides

(P = 0.321).

The decrease in the concentration of Pb and Cd after singeing shows that heat treatment can reduce the level of these metals in hides. The fact that Pb was the least reduced of all the other metals showed that it had a slow elimination rate as reported by Humphreys (1991). Though there was a decrease in the values of Pb after singeing, the concentration gotten were still above the maximum permissible levels; therefore, this still poses a threat to human health on consumption.

The mean concentrations of heavy metals in singed washed hides as shown in Table 1 are 4.15±2.69 for lead, 0.45±0.31 for cadmium, 8.27±5.07 for iron, 6.08±4.31 for copper and 2.24±1.77 for nickel. The concentrations of all the metals reduced considerably in the singed washed hides (after proper washing).

This is indicative that proper washing during processing of hides before consumption further reduces the concentration of heavy metals in them. Although these metals reduced in concentration and were still above the

Table 3. Correlation between heavy metals in USH and SH of hides in Nsukka slaughter house.

	Fe1	Ni1	Pb1	Cd1	Cu1	Fe2	Ni2	Pb2	Cd2	Cu2
Fe1	1	-	-	-	-	-	-	-	-	-
Ni1	0.337**	1	-	-	-	-	-	-	-	-
Pb1	0.204	-0.428**	1	-	-	-	-	-	-	-
Cd1	0.027	0.543**	-0.276*	1	-	-	-	-	-	-
Cu1	0.280*	0.661**	-0.323*	0.753**	1	-	-	-	-	-
Fe2	0.474**	0.317*	-0.236	-0.245	-0.012	1	-	-	-	-
Ni2	-0.186	-0.099	-0.468**	-0.333**	-0.270*	0.299*	1	-	-	-
Pb2	0.257*	-0.322*	0.839**	-0.189	-0.180	-0.177	-0.414**	1	-	-
Cd2	-0.014	0.417**	-0.269*	0.854**	0.819**	-0.265*	-0.273*	-0.155	1	-
Cu2	-0.049	0.409**	-0.602**	0.360**	0.456**	0.220	0.335**	-0.471**	0.367**	1

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

MPL except for Cu. For Pb, 100% of the hide samples were above the limit set by European Commission for Pb in hides irrespective of the treatment. This made all the 60 samples unwholesome for human consumption. Lead accumulates in the brain, liver, kidney and bones. According to Chang (1996), every 30 mg of Pb in a child's blood, causes his or her IQ to drop by 10 points. Exposure to toxic levels of Pb have also been shown to cause insomnia, nausea, headache, constipation, weight loss, anemia, malfunctioning of the kidney and reproductive organs (ATSDR, 1997b; Moore et al., 1987). This may also develop into delirium, convulsion, paralysis, coma and death (Kumar et al., 1985). Excess Pb has been shown to reduce the cognitive development and intellectual performance in children and to increase blood pressure and cardiovascular disease incidence in adults (Commission of the European Communities, 2002).

The concentration cadmium decreased steadily; the level left in the processed hide was still high. Reports have shown that Cd is toxic and unfit for human consumption and that food is one of the principal environmental sources of Cd (Baykov et al., 1996). Air borne cadmium deposits onto arable lands, where it is taken up by tobacco and food (WHO, 2010). Cd have been reported to have no known bio-importance in human biochemistry and physiology and consumption even at very low concentrations can be toxic (EU, 2002; Nolan, 2003; Young, 2005).

Iron (Fe) was detected in all the samples (100%) analyzed in each of the groups (USH, SH and SWH) and their mean concentrations were above the maximum permissible level. This is thus toxic and unfit for human consumption. Reports have shown that Fe is present in large quantity in most soil, making Fe the fourth most abundant element in the earth crust (Yahaya et al., 2009).

The concentration of Ni in singed hides was higher than that in the other groups and the values were above the maximum permissible level of Ni in food animals. Nickel is a carcinogen and therefore is of public health importance (Anonymous, 2003; Agency for Toxic Substance and Disease Registry, 2004). Small amounts of Ni are needed by the human body to produce red blood cells, but when in excess, Ni can become mildly toxic. Long term exposure to Ni can cause decreased body weight, heart and liver damage and skin irritation. Accumulation of Ni in vital body organs can cause genetic damage and cancer (Chang, 1996).

Copper was detected in all the hides analyzed, but only 20% of the hides had Cu concentrations above the maximum permissible level in both singed and unsinged hides and none (0%) of the singed-washed hides had values that were above the maximum permissible level recommended for Cu. Copper compounds are used as nutritional supplements in fertilizers and animal feed, fungicides and other agricultural chemicals and domestic sewage effluents (ATSDR, 1997). Copper toxicity is a much overlooked contributor to many health problems; including anorexia, fatigue, premenstrual syndrome, depression, anxiety, liver and kidney damage, migraine headaches, allergies, childhood hyperactivity and learning disorders.

At $p < 0.05$, correlation among elemental pairs was significant but weak. Weak correlation existed between Ni/Fe, Cd/Cu and Ni/Cu at $p < 0.01$. While at $p < 0.05$ Fe/Pb, Ni/Fe and Fe/Cu were weakly correlated.

The results showed that Pb/Pb ($r = 0.839$), Cd/Cd ($r = 0.854$), Cu/Cu ($r = 0.456$) and Fe/Fe ($r = 0.474$) pairs were positively correlated and significant at the 0.01 level in the singed and unsinged hides, while Ni/Ni ($r = -0.099$) was not statistically significant at both 0.01 and 0.05 levels as shown in Table 3.

The correlation between heavy metal pairs that were

Table 4. The mean concentration of heavy metals in waste water from washing of cattle hide.

Heavy metal	Concentration (mg/L)	WHO (mg/L)	NEMA (mg/L)
Lead	1.98	0.05	0.1
Cadmium	0.25	0.005	0.1
Iron	0.77	0.1	-
Copper	8.25	0.1	1
Nickel	1.48	0.05	1

NEMA: Maximum Permissible Limits for Discharge of Effluent or Waste Water. WHO; World Health Organization Guidelines for Drinking Water Quality (1984).

Table 5. Brine shrimp lethality test of the waste water.

Group	Concentration (ppm)	Mortality rate	
		Dead	Alive
A	7300	5	5
B	730	1	9
C	73	1	9
D	Control	0	10

negative indicates non common point source pollution, that is, pollution was probably not from the same source while those that were positively correlated may have shown common source pollution.

Water samples analysis shown in Table 4 revealed that the levels of all the metals were above the standards set by WHO and NEMA. This implies that washing of the hides after singeing may have transferred some of the heavy metals deposited on the surface of the hides as a result of singeing into the water used in washing it. It also implies that abattoir effluents discharged into nearby streams or used for irrigating nearby farm lands may be a source of heavy metal pollution in the environment.

Determination of the concentration of water effluent

Determination of the concentration of water effluent is calculated as:

Weight of watch glass (W) = 36.6452 g

Weight of watch glass + water sample (w) = 36.6525 g

$W - w = 0.0073 \text{ g} \times 1000 = 7.3 \text{ mg/ml}$

Therefore, the dry matter concentration of the water effluent was 7,300 ppm. The actual bioactive components of the waste water effluent include the already determined concentration in ppm of the elements in the hide.

The result of the BSLT in Table 5 of this study established the fact that the water effluent contains potent bioactive compounds. The compounds were rated moderate because of the slightly high LC_{50} (7316). The

ED_{50} value per general bioactivity was approximately 1/10th of the value of the LC_{50} in BSLT (McLaughlin et al., 1991). Therefore, the ED_{50} of the water effluent was approximated to be 731.6 ppm (0.732 mg/l). The surviving nauplii were dull and inactive which was an indication of central nervous system depression (Allurin et al., 2005; Mac Laughlin et al., 1991). This study showed that heavy metals concentration of water of 7.316 mg/kg may be toxic to the aquatic fauna, which by extension may affect the food chain.

Conclusion

Under the conditions of this study, it was clear that the cattle hide bio-accumulates different concentrations of heavy metals in both USH, SH and SWH. The levels of Cd, Fe, Ni and Pb far exceeded the maximum permissible levels and therefore posed human health threat to the hides consuming populace of the university and Nsukka communities. It could also be concluded that the high level of heavy metal concentrations in hide samples in the present study may be as a result of both the method of singeing, rearing and environmental factors.

The high level of heavy metals in the singed hides may also have contributed to the high concentration gotten in the hides after singeing. Therefore, investigations of heavy metals should not only be done at the abattoir, but also at farm levels, during grazing, etc., to ensure that these animals do not take in harmful quantities of metals which might show up in the processed final product. This work also revealed that waste water from hide processing in the abattoir contains heavy metals and is



Figure 1. Tyre used to fuel wood for singeing.



Figure 2. Hides placed on metal stripes during singeing.

capable of destroying the aquatic system; therefore, adequate monitoring should be done at abattoir levels to ensure that these waste are properly disposed. The potential risk of heavy metals bioaccumulation and toxicity may continue to increase in future depending on the extent of industrial influx into the environment due to man-made activities and abuses. At present, there are no set of maximum permissible levels for trace or toxic elements in hides in Nigeria; therefore, in order to protect public health and ensure food safety; it is recommended that maximum permissible levels for heavy metals in food of animal origin be established and reinforced in Nigeria.

Programs aimed at educating abattoir workers, herdsmen and other stakeholders and periodic monitoring of these metals in our environment is therefore recommended.

Conflict of interest

The authors have no conflict of interest.

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Full Length Research Paper

Bovine hydatidosis: Prevalence, public health and its economic significance in and around Harar, Ethiopia

Dinaol Belina^{1*}, Getnet Fekadu¹, Eyasu Zegaye¹ and Sena Belina²

¹Haramaya University College of Veterinary Medicine, P.O. Box 138, Dire Dawa, Ethiopia.

²Jimma University School of Health Science P.O. Box, 43 Jimma, Ethiopia.

Received 15 October 2014; Accepted 9 December, 2014

Both cross-sectional and retrospective studies were conducted from October, 2011 to June, 2012 in and around Harar to determine prevalence, public health and economic significance of bovine hydatidosis. Out of 384 cattle examined with thorough carcass inspection at Harar city municipal abattoir, 36 (9.4%) were found to be infected with hydatid cyst. Significant differences were found among adult and young, poor, medium and good body condition cattle. However, no significant differences were found between sexes. Infected cattle harbored one or more hydatid cysts that were unequally distributed to lung, liver, kidney and spleen. In this study, 27 (52.94%) fertile cysts were observed and the rate of cyst calcification was higher in kidney (50%) than in other visceral organs. The direct and indirect annual financial loss from organ condemnations and carcass weight loss at the abattoir was estimated to be about 841,419.3 ETB. The retrospective case-book survey (2008 to 2011) of hospitals, health centers and clinic were indicated to be 0.195% (n=98,349) prevalence of human hydatidosis. A questionnaire survey and interview were also supplemented to a society in and around Harar to assess public awareness on hydatidosis. For this, 600 individuals (500 for questionnaires and 100 for interviews) were included using stratified random sampling in which educational level and profession were considered for stratification. This questionnaire survey and interview were made giving emphasis to way of acquiring hydatidosis and the individuals' source of information about the disease as a zoonosis; the result showed schools and health extension workers were the leading information sources in the society. In conclusion, results of the present study showed bovine hydatidosis as an importantly producing great economic loss and public health hazardous at the study area. Therefore, public awareness creation, and appropriate control and prevention mechanisms in animal population should be done.

Key words: Abattoir, bovine, financial loss, hydatidosis, prevalence, public health, Harar, Ethiopia.

INTRODUCTION

In spite of large livestock population in Ethiopia, the productivity remains marginal due to many factors like

malnutrition, management problems, prevalent diseases, etc. Among these hydatidosis is one of the important

*Corresponding author. E-mail: belina.timketa@gmail.com. Tel: 091-383-5631.

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parasitic disease of livestock that has both economic and public health significance (FAO, 1995). Hydatidosis (Cystic *Echinococcosis*) is a zoonotic disease caused by the larval stages of *Echinococcosis granulosa* for which domestic intermediate hosts (cattle, sheep, goats and camels) are major reservoirs for the occurrence of human hydatidosis (Torgerson and Deplazes, 2009). Dogs are the obligate final host and infected by ingesting infected offals (lung, liver, kidney, spleen, etc). Human and wide varieties of other animals also serve as an accidental intermediate hosts for the parasite (Thompson and Mcmans, 2002).

Hydatidosis constitute public health problem worldwide, particularly it causes heavy burden in developing countries (Eckert and Deplazes, 2004; Chhabra and Singla, 2009). Its transmission is most intensive in livestock raising regions where veterinary service is unsatisfactory and offal from slaughtered animals is accessible to dogs. Cattle and other intermediate hosts contract hydatidosis by grazing on pastures contaminated with dog faeces that contain eggs of the cestode (Acha and Szyfres, 2003). Man is an intermediate host and Plays no role in the transmission of the hydatidosis, unless the individual is eaten by carnivores. Nevertheless, people's sanitary habits make human being the main agent responsible for perpetuating the infection by feeding dogs viscera that contain hydatid cysts (Jobre et al., 1996; Chai, 1995). The life cycle of this parasite is completed when organs containing hydatid cysts are consumed by dogs (Torgerson and Deplazes, 2009). Therefore, theoretically the infection would die out if man ceased re-infecting dogs by feeding them raw viscera (Chai, 1995). Close contact with dogs and deficient personal hygiene practices such as not washing hands and vegetables before eating, and water contaminated with infected dog faeces are important factors in the transmission of human infection. Coprophagic flies may also serve as mechanical vector for eggs of the cestode (Acha and Szyfres, 2003).

The larval stage of hydatid cyst is fluid filled bladder containing cellular laminated layer with internally nucleated germinal layer. If the scolices separate from the inner lining of the capsule they caused hydatid sand (OIE, 2001).

The pathogenesis of hydatidosis heavily depends on the extents and severity of infections and the organ on which it is situated. The occasional rupture of hydatid cysts often leads to sudden death due anaphylaxis, hemorrhage and metastasis (Jobre et al., 1996); hence, the disease is associated with severe morbidity and disability. The status of hydatidosis in animals has been studied in some regions of Ethiopia and indicated hydatidosis is widely spread with great economic and public health significance (Kebede et al., 2009a). Apart from animal population, the status of human hydatidosis is among the most neglected parasitic diseases. In general,

hydatidosis results in enormous economic loss in animal population with risk of public health hazards. Therefore, the main objectives of this study were to determine prevalence and financial losses of bovine hydatidosis at Harar city municipal abattoir and to elucidate public health significance of hydatidosis and assess public awareness on the disease in the study area.

MATERIALS AND METHODS

Study area

This study was conducted in and around Harar, the capital city of Harari regional state, Ethiopia. This area constitutes 76% mid-subtropical weather of "weynadega" and 24% desert type climate of "kola" (NMSA, 2011). During this study, in average 40 cattle were slaughtered per day at the Harar city abattoir. The abattoir was not provided with proper waste disposal system as even condemned abattoir materials were accessible to dogs.

Study design

Both cross sectional and retrospective studies supported with questionnaires and interviews were conducted.

Study population

Local breed of apparently healthy cattle of different body condition, sex and age groups coming from neighboring provinces of Harar were included in the study. Most of the study animals were males though females with reproductive problem, poor performance and end productive life were also encountered. Concerning public health aspect, questionnaires were distributed to individuals living in and around Harar.

Sample size determination and sampling method

Sample size was calculated by considering 50% expected prevalence at 95% confidence level and 5% precision (Thrusfield, 2005). Accordingly,

$$N = (1.96)^2 P_{exp}(1-P_{exp})/d^2 = 384.$$

Then these animals were included in the study using systematic random sampling method. 500 individuals filled the questionnaires and 100 were interviewed applying stratified random sampling, using educational level and profession for stratification. Case book survey was also conducted to determine retrospective prevalence of human hydatidosis in patients that had come to hospitals, health centers and public clinic in and around Harar.

Experimental

Ante-mortem inspection

During ante-mortem inspection, each of the study animals was given an identification number. Age, origin, sex and body condition scoring of the study animals were made. The body condition score

was classified into poor, medium and good categories (Heinonen, 1989). Young and adult age groups were encountered following their dentations.

Post mortem inspection

During post mortem examination organs especially liver, lung, spleens, kidney, heart, muscle and head part as a whole were systematically inspected for the presence of hydatid cyst by applying the routine meat inspection procedure of primary examination followed by secondary examination (Alula, 2010). The primary examination involves visualizations of the organs whereas secondary examination involves further incision of each organ into pieces and whenever evidence of the cyst was found, it was classified as live or calcified and the cyst distribution to organs was also recorded.

Fertility and viability tests

Positive or suspected samples were taken to the laboratory for the cyst identification, fertility and viability tests were performed. Of the collected hydatid cysts, individual cysts were carefully incised and examined for protoscoleces, which are similar to the appearance of white dots on the germinal epithelium (Figure 1); such cysts were characterized as fertile cysts; fertile cysts were subjected to viability test. A drop of the sediment containing the protoscoleces was placed on the microscopic glass slide and covered with a cover slip and observed for amoeboid like peristaltic movements. For clear vision, a drop of 0.1% aqueous eosin solution was added to equal volume of protoscoleces in hydatid fluid on the microscopic slide with the principle that viable protoscoleces should completely or partially exclude the dye while the dead ones took it up. Furthermore, infertile cysts were further classified as sterile or calcified (Soulsby, 1982) (Table 2).

Estimated financial loss

Losses due to organ condemnation was calculated by considering information on the retail market price of condemned organs (Ogunirale and Ogunrinade, 1980), obtained from butcher shops of Harar city during the study period. The average annual slaughter rate of cattle at the abattoir was estimated from the retrospective data of the last two years. In line with this:

$$LOS = MAK \times PH [(P_1 C_1) + (P_2 C_2) + (P_3 C_3) + (P_4 C_4)]$$

where LOS = loss due to organ condemnation, MAK = annual average number of cattle slaughtered at Harar city municipal abattoir, PH = prevalence of hydatidosis, P_{1-4} = prevalence of each organ condemned, C_{1-4} = main retail cost of single organs condemned.

The financial loss encountered from carcass weight losses was also calculated by considering retail market cost of 1 kg beef at Harar city, and 5% carcass weight loss due to hydatidosis was considered as described by Polydrous (1981). Accordingly,

$$LCWL = MAK \times PH \times CPB \times 5\% \times 126 \text{ kg,}$$

where LCWL = loss from carcass weight loss, NAS = average number of cattle slaughtered annually, CPB = current average price of 1 kg beef, 126 kg = average carcass weight dressing percentage of an adult zebu cattle. The total annual financial loss was the sum of losses from organ condemned and carcass weight lost.

Questionnaire and retrospective studies

Evaluation on public awareness about hydatidosis was done through well designed interview and questionnaires. Stratified random sampling method was considered based on educational level and profession. Accordingly, designed questionnaires were supplemented to 500 selected people of whom 200 were elementary and high school students, 100 were university and college students, 50 were health professionals and 150 non health professionals of different departments. In addition, 20 health and 20 non health professionals, 10 veterinarians and 50 illiterate local people were interviewed about their custom of consuming backyard slaughtered beef, drinking surface water, washing vegetables and their hands before meal, attitude of offering dogs raw viscera and their close contact with stray dogs in their social activity. Mass media, schools they attended and have been attending, health extension workers and other informal sources (including family, religious leader advises, etc.) were also filled in questionnaires and interviewed as a source of information about hydatidosis for individuals.

Retrospective cystic echinococcus cases from the total ultrasound admitted patients during January, 2008 to December, 2011 in hospitals and cases registered as hydatidosis at health centers and clinic in and around Harar were collected from the institutions case book reports.

Data management and analysis

The information or data about bovine hydatidosis was collected and later entered in to Microsoft excel 2010 spreadsheet and analyzed using SPSS statistical software version 20. Prevalence data were analyzed by chi-square, and descriptive statistics were also used. $P \leq 0.05$ was considered as statistically significant at 95% CI.

RESULTS

Prevalences

The present study showed 9.4% (n=384) bovine hydatidosis at Harar city municipal abattoir. There was a significant difference in the harboring of hydatid cyst between age groups and body condition scores. The prevalence was significantly higher in adult and poor body condition than in young, and medium, good body condition cattle ($p < 0.05$). However, there was no significant difference between sexes ($p > 0.05$) (Table 1).

Among the infected organs, the highest prevalence was found in liver and followed by lung, which accounted for 56.86 and 27.45%, respectively. The rate of cyst calcification was by far higher in kidney (50%) than in other visceral organs, the least calcification rate (20.69%) was encountered in liver.

Financial loss assessment

Cystic echinococcus financial loss assessment was made based on the direct and indirect losses. The direct loss was losses due to condemnation of the offals like lung,

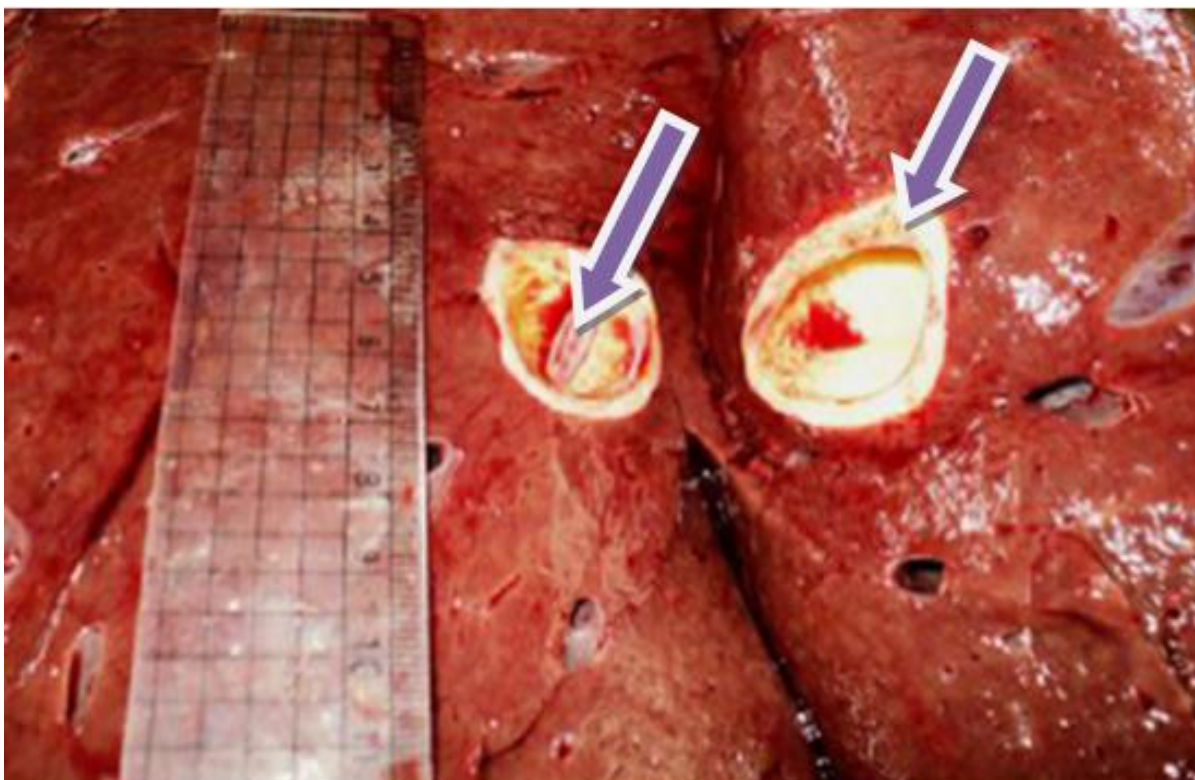


Figure 1. Cattle liver with cross section of hydatid cyst.

Table 1. Prevalence of bovine hydatidosis by sex, age and body condition score at Harar city municipal abattoir.

Variable	Levels	No. examined	No. positive (%)	P value
Sex	Male	292	30 (10.28)	0.061
	Female	92	6 (6.52)	
Age	Young	161	9 (5.60)	0.042
	Adult	223	27 (12.11)	
Body condition score	Poor	94	20 (21.28)	0.012
	Medium	25	2 (8.00)	
	Good	265	14 (5.28)	
-	Total	384	36 (9.40)	-

spleen, liver and kidney, whereas carcass weight loss due to hydatid cyst is indirect loss. The retail market price of different edible offals' and 1 kg beef in Harar city were considered as a parameter for this calculation (Table 3).

Therefore, by applying the formula of Ogunirale and Ogunrinade (1980) and Polydrous (1981), the annual financial loss due to bovine hydatidosis at the study area

could be as followed.

Direct loss (DL)

$$\text{LOS} = \text{MAK} \times \text{PH} [(P_1C_1) + (P_2C_2) + (P_3C_3) + (P_4C_4)] = (10950 \times 9.4\%) [(7.84\% \times 5) + (27.45\% \times 45) + (56.86\% \times 85)]$$

Table 2. The distribution and conditions of hydatid cysts in different organs of cattle slaughtered at Harar city municipal abattoir.

Organ	Hydatid cyst condition (%)			total cysts
	Fertile	Sterile	Calcified	
Lung	9 (64.29)	2 (14.29)	3 (21.43)	14 (27.45)
Liver	14 (48.28)	9 (31.03)	6 (20.69)	29 (56.86)
Spleen	3 (75.00)	0	1 (25.00)	4 (7.84)
Kidney	1 (25.00)	1 (25.00)	2 (50.00)	4 (7.84)
Total	27 (52.94)	12 (23.53)	12 (23.53)	51 (100)

Table 3. Retail market price of different organs and carcass at butcher shops in Harar city.

Organ	Retail market price (ETB)
Lung	45
Liver	85
Spleen	5
Kidney	15
1 kg beef	120

$$+ (7.84\% \times 15)] \\ = 63268.50\text{ETB}$$

Indirect loss (IL)

$$\text{LCWL} = \text{MAK} \times \text{PH} \times \text{CPB} \times 5\% \times 126 \text{ kg} \\ = 126 \times 5\% \times 10950 \times 9.4\% \times 120 \\ = 778150.8 \text{ ETB}$$

Total financial loss (TFL)

$$\text{TEL} = \text{DL} + \text{IL} \\ = 63268.50 + 778150.8 \\ = 841,419.3 \text{ ETB; about } \sim \$46,745.5$$

Questionnaire and retrospective studies

Results of questionnaire and interview showed that 74.3 and 48.8% of the participants got information about way of acquiring hydatidosis from schools and health extension workers, respectively (Table 4). On the other hand, about 38.0% of the participants had direct contact with stray dogs in their daily activities. The results also indicated only 84.7% of our study population washed their hands and vegetables before they eat it (Table 5).

Case book analysis showed that out of 98,349 total patients admitted for ultrasound and clinical examinations

at hospitals, health centers and clinic in and around Harar, 192 (0.195%) individuals were registered as positive cases for hydatidosis. There were prevalence variations among the institutions and the highest prevalence (0.5%) was found at Abdi Boru clinic (Table 6).

DISCUSSION

The present 9.4% prevalence of bovine hydatidosis at Harar city municipal abattoir was in agreement with the report of 9.38% (Wubet, 1987), from Hararge region; however, this prevalence was less than the findings of 37.7% (Roman, 1987), 34.05 and 15% (Kebede et al., 2009b; Belina et al., 2012), and 32.1% (Berhe, 2009), from Gonder, Bahir Dar and Mekele, respectively. Relatively lower prevalence in current study may be due to adverse conditions of high temperature and low humidity encountered at the origin of animals on survival of *E. granulosus* egg (Thompson and Allsopp, 1988), as majority of the study animals came from low land areas. The prevalence variations with geographical regions may also have some connection with cultural and religious taboos such as backyard slaughtering of animals, attitudes in offering uncooked infected offal to pet animals, close contact with stray dogs in social activities and in general poor public awareness about the hydatidosis. Njoroge et al. (2002) explained environmental conditions, livestock stocking intensity and

Table 4. Sources of information in way of acquiring hydatidosis by study participants in and around Harar.

Strata	Mass media	Electronic media	Schools	Health extension	Others
Elementary and high school students (n=200)	46 (23.0)	21 (10.5)	164 (82.0)	149 (74.5)	59 (31.0)
University and College Students (n =100)	57 (57.0)	44 (44.0)	96 (96.0)	36 (36.0)	41 (74.0)
Health Professionals (n=70)	32 (45.7)	5 (7.1)	67 (95.7)	0 (0)	15 (21.4)
Non health profess (n =170)	96 (56.5)	12 (7.0)	109 (64.1)	64 (37.6)	85 (50)
Veterinarians (n =10)	2 (20.0)	0 (0)	10 (100)	1 (10)	0 (0)
Illiterate local people (n =50)	2 (4.0)	0 (0)	-	43 (86.0)	14 (34.0)
Total (N= 600)	235 (39.2)	82 (13.7)	446 (74.3)	293 (48.8)	214 (35.7)

Table 5. Knowledge of the study participants on way of acquiring hydatidosis in and around Harar.

Strata	Eat backyard slaughtered beef	Close contact with stray dogs	Feed dogs raw viscera	Wash vegetables and their hands before eat	Drink surface water
Elementary and high school student	74 (37.0)	83 (41.5)	61 (30.5)	168 (84.0)	42 (21.0)
University and college students	36 (36.0)	67 (67.0)	69 (69.0)	88 (88.0)	9 (9.0)
Health professionals	14 (20.0)	7 (10.0)	9 (12.9)	60 (85.7)	0 (0)
Non health professionals	36 (21.2)	42 (24.7)	37 (21.8)	163 (95.9)	9 (5.3)
Veterinarians	1 (10.0)	2 (20.0)	0 (0)	10 (100)	3 (30.0)
Illiterate local people	38 (76.0)	27 (54.0)	32 (64.0)	19 (38.0)	35 (70.0)
Total	199 (33.2)	228 (38.0)	208 (34.7)	508 (84.7)	98 (16.3)

movement in different regions contribute to the prevalence differences. Attributing to the work of Belina et al. (2012), our current study indicated there was no significant difference ($p > 0.05$) between sex groups, though higher prevalence was found in male animals. This may be due to small number of female animals slaughtered at the abattoir during our study. Females were kept for breeding, hence only females with reproductive problem, poor performance and end productive life were slaughtered at the abattoir. However, significant ($P = 0.01$) higher prevalence was found in animals with poor body condition score which probably reflected the effect of relatively high cyst burden. According to Polydrous (1981) and Battelli (1997), moderate to severe infection of the parasite leads to live weight loss, retarded performance and growth with reduced quality of meat and milk. Our finding also showed there was a significant difference between age groups ($p < 0.05$) in harboring hydatid cyst. Majority of the studied animals were adult and hence, they were exposed to the disease (parasitic ova) over a long period of time with an increased possibility of acquiring the infections than younger ones. It has been stated that the easier development and the fertility rate of hydatid cysts may show the tendency to increase with advancing age of the hosts (Himonas et al., 1987). In the present study, the highest cyst frequency was observed in liver and

followed by lung which is in agreement with report of Belina et al. (2012). This is explained by the fact that livers and lung possess the first greater capillary sites encountered by the migrating *E. granulosus* oncosphere (hexacanth embryo) which adopt the portal vein route and primarily negotiate hepatic and pulmonary filtering system sequentially before any other peripheral organ is involved (Alula, 2010).

The annual financial loss of 841,419.3 ETB, in our study due to bovine hydatidosis from offal condemnation and carcass weight loss was greater than the findings of Yilma (1984), 813,526.46, Wubet (1987), 64,920.00 and Kebede et al. (2009a), 25,608.00 ETB from Debrezeit abattoir, Hararge zone, and Tigray region, respectively; however, by far lower than the report of Regassa et al. (2010), 1791625.89 ETB from Hawassa municipal abattoir. According to Alula (2010), the financial loss varied from region to region and even from abattoir to abattoir based on the prevalence of hydatidosis, mean annual number of cattle slaughtered at different abattoirs and the retail market price of organs.

The results of the questionnaire and interview showed that 74.3% of the participants got information about way of acquiring hydatidosis from schools. Information from school was the leading one in this study. However, Sisay et al. (2012) reported that majority of the elementary and high school students get information about zoonotic

Table 6. Prevalence of human *Echinococcus* cases at hospitals, health centers and clinic in and around Harar (January 2008 - December 2011).

Sub-total (%)		Cases	44 (0.23)	67 (.25)	32 (0.14)	49 (0.16)	192 (0.2)
		Visited	19435	26243	22796	29875	98349
clinic	Abdi boru (%)	Cases	15 (0.53)	13 (0.52)	6 (0.21)	12 (0.61)	46 (0.5)
		Visited	2852	2498	2903	1958	10211
Health center	Adelle (%)	Cases	10 (0.37)	18 (0.63)	8 (0.28)	11 (0.04)	47 (0.4)
		Visited	2716	3628	2876	2724	11944
	Haramaya (%)	Cases	9 (0.30)	17 (0.58)	12 (0.29)	14 (0.04)	52 (0.4)
		Visited	3016	2927	4139	3481	13563
Hospital	Jugol (%)	Cases	6 (0.12)	12 (0.15)	4 (0.07)	7 (0.07)	29 (0.1)
		Visited	4820	8016	6016	10282	29134
	Hiwot Fena (%)	Cases	4 (0.07)	7 (0.08)	2 (0.03)	5 (0.04)	18 (0.05)
		Visited	6031	9174	6862	11430	33497
Years			2008	2009	2010	2011	Total

Visited: Number of patients who visited the hospital/health center/clinic; Cases: number of patients who diagnosed as positive for hydatidosis.

diseases from their families in the form of advice, though most health professionals get their information from medical schools they attended. On the other hand, 48.8% of our participants got information about way of acquiring hydatidosis from health extension workers. Health extension workers have high chance of getting all social classes from all corners and they have been working on zoonosis and communicable disease (working on prevention) is their main objective, as Ethiopian government has been working with the principle of at least one health extension worker to one kebele/PA. Furthermore, the most important social classes (86% of illiterate local people) got information about way of acquiring hydatidosis from health extension workers. The study also showed that none of the illiterate local people got information about the disease from media and schools.

Contact with stray dog, not washing vegetables and their hands before eating are important way of acquiring hydatidosis (Ketema, 2010). However, in the present study, 38% of the participants had close contact with stray dogs in their social activities, and only 84.7% of the study population washed their hands and vegetables before they ate. Supporting this study, Tamiru et al. (2008) and Avery (2004) reported in their previous study, that eating uninspected backyard slaughtered raw meat had been considered as risk factor for hydatidosis. This could be due to the low level of awareness of the people on the importance of using inspected meat, because of cultural beliefs that raw meat is better than cooked one and the deeply established traditional habit of eating raw meat in the country (Sisay et al., 2012). About 69% of the

university and college students, 64% of illiterate local people and even 12.9% health professionals support feeding dogs raw viscera unlike veterinarians. None of the veterinarians were in favor of cultural beliefs and traditional habit of offering uncooked infected offal to dogs. Veterinarians possess better knowledge on animal diseases and food productions, as well as training in ecological, economic and human cultural issues, make them the leaders in developing and implementing new methods of promoting sustainable public health (King and Khabbaz, 2003). Sisay et al. (2012) also stated, besides educating health professionals and directors of public health, it is important to increase the involvement of veterinarians in public health improvement.

Retrospective case book analysis of patients admitted for ultrasound and clinical examinations at hospitals, health centers and clinic in and around Harar showed 0.195% (192/98,349) human hydatidosis. This prevalence was higher than the report of 0.044% (Belina et al., 2012) from Bahir Dar. The higher current prevalence might be because of the low public awareness, backyard slaughtering practices, poor control measures and presence of a large number of stray dogs that contributed to human infection. In addition to this, our study area lacks modern diagnostic facilities, and there was inability to offer treatment by the most vulnerable sections of the society. However, 1.6 and 0.5% human hydatidosis were also screened with ultrasound from southern part of Ethiopia in 1987 and 1996, respectively (Eckert et al., 2002). Battelli (2003) also reported 0.22% human cases from Portugal.

In conclusion, the present study showed 9.4% prevalence of bovine hydatidosis with significant estimated financial loss in and around Harar. Body condition score and age groups cattle were statistically risky factors unlike sexes in the study area. The result also showed liver was the most frequently affected organ and cyst calcification was by far higher in kidney among other examined organs. In average, about 841,419.3 ETB financial losses were encountered in the current study. 0.195% human hydatidosis was recorded from retrospective hospitals, health centers and clinic case book analysis that hydatidosis is an important zoonotic disease. The results of the questionnaire and interview data showed that majority of the participants got information about way of acquiring hydatidosis from schools and health extension workers. In addition, people in and around Harar do not have enough knowledge about way of acquiring hydatidosis where majority of the people were accustomed to consuming backyard slaughtered beef and even offering infected raw offals to dogs. Therefore, based on this study, we recommended that effective control and prevention mechanisms in animal population should be done and stray dogs have to be restricted; there must be legislation that will strictly prevent backyard slaughtering practice, and public health veterinarians should work with medical professionals and reach the rural areas; schools and other public institutions have to teach society at large, and lastly creation of public awareness about hydatidosis as zoonosis and the present works of health extension workers in Ethiopia should be encouraged and further expanded.

Conflict of interest

The authors declare that there is no conflict of interest.

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Review

Traumatic urinary bladder injuries in small animals

Muhammad Sa'idu Tanko^{1*}, Cheh Augustine Awasum², Adamu Zoaka Hassan², Bala Usman¹,
and Balarabe Magaji Jahun¹

¹Veterinary Teaching Hospital, Ahmadu Bello University, Zaria, Kaduna State, Nigeria.

²Department of Veterinary Surgery and Radiology, Ahmadu Bello University, Zaria, Nigeria.

Received 25 April, 2014; Accepted 2 December, 2014

Traumatic urinary bladder injuries in the recent times are considered to be of great importance in veterinary medicine, as they can lead to significant morbidity and subsequent mortality when diagnosed late or left untreated. However, the true incidence rates, absolute treatment recommendations and prognoses of lower urinary tract traumas are not available in literatures as the majority of specific information regarding lower urinary tract injuries in small animals exist as isolated case reports or small case series. Urologists may only encounter traumatic bladder injuries in their practice, because of the current modernization and human activities leading to increase in occurrence of the injuries. This paper reviews mainly the literatures and reports on the causes, clinical signs, diagnosis and management of traumatic urinary bladder injuries (blunt, penetrating and iatrogenic bladder traumas) to assist clinicians in this specialty. History, presenting clinical signs and laboratory evaluations are the diagnostic tools of bladder injuries and in predicting prognosis when treated. Despite presentation with nonspecific signs, haematuria and abdominal tenderness are the most common clinical signs of bladder rupture in animals. Early diagnosis and repair of bladder rupture offers good prognosis. Management of these conditions may require either solely medical or surgical intervention, while others will require a combined management intervention.

Key words: Injuries, review, small animals, traumatic, urinary bladder.

INTRODUCTION

Trauma of lower urinary tract is frequently recognized in veterinary patients and is the most common cause of uroperitoneum in cats, dogs, and humans (Aumann and Worth, 1998; Gannon and Moses, 2002; Rieser, 2005). In the previous decades, traumatic (blunt or penetrating) bladder injuries were considered to be relatively uncommon in animals mainly due to the anatomical position of the bladder, located within the bony structures of the pelvis and is protected from most external forces (Fletcher and Clarkson, 2011). However, as the bladder fills, it moves into the abdomen and makes it more

vulnerable to be ruptured or injured (Bartges and Polzin, 2011). In the young animals, the pelvic bones are not fully developed and so it is more easily injured than in the adult animals (Dyce et al., 2003).

Currently, urinary bladder rupture is the most common traumatic urinary injury in dogs and cats (Thornhill and Cechner, 1981). It is more common in male dogs due to less urethral compliance and dilation in response to increased intravesicular pressure (Thornhill and Cechner, 1981). Mechanisms for bladder rupture include direct penetration by fracture fragments or sudden increase in

*Corresponding author. E-mail: samutanko@gmail.com.

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intravesicular pressure (Selcer, 1982). Multiple severe injuries involving the urinary bladder are common with abdominal trauma (Selcer, 1982; Cass, 1984; Weisse and Aronson, 2002) and mortality in these patients is alarming, 12 to 22% (Corriere, 1986; Cass and Luxenberg, 1987). In a study of 1,000 consecutive veterinary trauma patients evaluated at a single hospital, approximately 12% had significant abdominal injuries with involvement of the urinary bladder in some cases (Kolata and Kraut, 1974). Sura (2011) reported that, between 1966 and 1971, ruptured urinary bladder was confirmed in 26 dogs and 14 cats at one institution; 84.6% were due to trauma and 46.2% had associated pelvic fractures (Burrows and Bovee, 1974). Similarly, urinary bladder rupture has been reported by Whitney and Mehlhaff (1987) and Vnuk and Pirkic (2003) in 1/119 and 3/132 cats, respectively with high-rise syndrome. Also undifferentiated abdominal injury has been reported in 12/81 dogs injured by this same mechanism (Gordon and Thacher, 1993).

The true incidence rates, absolute treatment recommendations and prognoses of lower urinary tract trauma are not available in literatures as majority of the specific information regarding lower urinary tract injuries in companion animals exists as isolated case reports or small case series (Sura, 2011). In recent time of modernization increase incidence of bladder injuries is expected as a result of modern transportation preferences for both humans and their animals, increasing reliance on motor vehicles with advances in engine and mobile parts technology (Dobrowolski *et al.*, 2002). Domestic or professional accident and violence including terrorist activities also contribute to the increasing frequency of bladder injury (Dobrowolski *et al.*, 2002).

It is well established that prompt recognition and early management of these urological injuries can significantly reduce morbidity and mortality (Kong *et al.*, 2011; Sura, 2011). Delay in diagnosis of urinary tract trauma increases mortality rate (Sura, 2011). Death occurs 47 to 90 h after experimental urinary bladder rupture (Burrows and Bovee, 1974), although in traumatic cases, mortality is typically from associated sustained injuries (Aumann and Worth, 1998).

AETIOLOGY OF TRAUMATIC BLADDER INJURY

Lower urinary tract injury may be caused by external or iatrogenic trauma (Sura, 2011). Similarly, acquired urinary bladder injuries can occur as a result of either external (blunt or penetrating) or iatrogenic trauma with similar frequency (Carlin and Resnick, 1995). Kolata and Johnston (1975) reported that out of 600 consecutive dogs injured in motor vehicle accidents, 2.5% had urinary tract trauma. Additionally, a study of 100 consecutive dogs sustaining pelvic fractures found that 39% had urinary tract injury detected with contrast radiography and

the incidence of injury did not correlate with the severity of fracture (Selcer, 1982). In human patients, it is estimated that 10% of adult humans with external trauma sustain urinary tract injury (Tezval and Tezval, 2007).

According to Khan *et al.* (2004) in a retrospective review of hospital records, over a 10-year period, reported that bladder trauma due to motor vehicle collisions accounted for 35%, iatrogenic causes 35%, falls responsible for 20% and gunshot wounds amounted to 10% of the injuries in 260 identified patients with bladder injuries. Similarly, a 5-year survey from 61 urological departments by Dobrowolski *et al.* (2002) recognized 512 cases of bladder injuries out of which 210, 251, 41 and 10 were due to motor vehicle collision, iatrogenic, falls from height and crush injuries respectively.

Clinical signs

Evidence of urinary tract injury may not be apparent initially and development of clinical signs can be protracted (Bjorling, 1984; McLoughlin, 2000; Rieser, 2005). Clinical signs of lower urinary tract injury may be associated with uroperitoneum which include abdominal pain, dehydration, ballotment of a fluid wave, hematuria or dysuria, progressive depression, hypothermia, and other signs of external trauma (Burrows and Bovee, 1974; Pechman, 1982; Gannon and Moses, 2002).

The clinical signs of bladder injury are relatively nonspecific (Kong *et al.*, 2011). Presence or absence of hematuria, ability to void voluntarily, and presence of a palpable bladder do not predict urinary tract integrity (Burrows and Bovee, 1974; Rieser, 2005). Delayed signs are those of uremia and peritonitis, and may be suggestive of other organ or system abnormalities (Rieser, 2005). In a study on 26 cats with uroperitoneum, the most common historical complaints, other than anuria, were vomiting and lethargy (Aumann and Worth, 1998). Vomiting may begin approximately 24 h prior to detection of severe azotemia (Burrows and Bovee, 1974). Presence of infected urine in the abdomen may lead to systemic sepsis (McLoughlin, 2000). It is also reported in a study that there is strong correlation that exist between pelvic fracture and gross haematuria in patients with bladder rupture, where 85% of the patients that sustained pelvic fracture also presented gross haematuria (Morey *et al.*, 1999). Kong *et al.* (2011) stated that, 100% of all patients with bladder injuries present gross haematuria and its presence in conjunction with pelvic trauma is a well-documented predictor of the injury. Although, clinical signs of bladder injury are nonspecific, Bartges and Polzin (2011) published works on clinical and experimental studies of urinary bladder rupture, where the earliest clinical sign noted was abdominal tenderness, and then later followed by vomiting. Progressive dehydration and uremia eventually culminates into death within 72 h (Meynard, 1961; Burrows and Bovee, 1974).

Diagnosis

Generally, diagnosis of bladder trauma is primarily based on case history of the patient, presenting clinical signs, and laboratory evaluations.

The historical evaluation should include relevant information on possible exposure to traumatic object(s), frequency of urination, volume of urine produced, changes in water intake, appearance and odour of urine, and the presence or absence of polysystemic signs of disease (Bartges and Polzin, 2011). General information that should also be gathered from pet owners include information on husbandry, appetite, diet fed, medications administered, vaccination and deworming status, possible exposure to infectious agents or toxins, changes in behaviour, etc (Bartges and Polzin, 2011).

As many of these animals are presented after sustaining blunt trauma, extreme caution and close monitoring of the patient are essential, as a previously unsuspected diaphragmatic defect may become apparent (Carter and Wingfield, 1989; Dzyban and Labato, 2000). Common presenting clinical signs of bladder trauma are associated with uroperitoneum including azotemia, hyperkalemia, hypernatremia, hyperphosphatemia, and metabolic acidosis (Gannon and Moses, 2002; Rieser, 2005)

Abdominocentesis is necessary to definitively diagnose uroabdomen (Sura, 2011). Although different imaging techniques including retrograde cystography (urethrocystography) (Sandler et al., 1998; Feeney and Anderson, 2011), cystoscopy (Gilmour et al., 1999; Byron and Chew, 2011), ultrasonography (Bigongiari and Zarnow, 1994; Helling and Wilson, 2007; Hecht and Henry, 2011), computed tomography, angiography, and magnetic resonance imaging (Ben-Menachem et al., 1991), excretory urography (Werkman et al., 1991; MacLeod and Wisner, 2011) as well as surgical exploration (Allen et al., 2001) are employed as diagnostic tools.

Survey thoracic and abdominal radiography are obtained in all cases of trauma to evaluate diaphragmatic integrity, identify pneumothorax, hemothorax, pulmonary contusions and pertinent fractures (Sura, 2011). Radiographic evidence of urinary tract trauma includes loss of abdominal or retroperitoneal detail, lack of a distinct urinary bladder, and displacement or nonvisualization of a kidney (Pechman 1982).

The most reliable noninvasive means of detecting urinary tract trauma is via contrast radiography (Pechman, 1982; McLoughlin, 2000). Urethral tears and bladder rupture can be visualized by urethrocystography, although complete filling of the urinary bladder is required to demonstrate small defects (McLoughlin, 2000).

However, the standard and most accurate diagnostic procedure for detecting bladder rupture is the retrograde cystography (urethrocystography) (Baniel and Shein, 1994; Sandler et al., 1998; McLoughlin, 2000; Feeney

and Anderson, 2011) with accuracy rate of 85 to 100% (Sandler et al., 1998; Deck et al., 2000) and it is usually made easily on cystography when the injected contrast is identified outside the bladder (Lynch et al., 2003). In a study of experimental urinary tract rupture in 14 dogs, contrast cystography diagnosed 100% of cases (Burrows and Bovee, 1974). Similarly, positive contrast urethra-cystography delineated all cases of urinary bladder and urethral trauma in dogs with pelvic fractures (Selcer, 1982).

Management

Opinion has now changed regarding surgical management of urinary bladder rupture. Speed was considered of optimum concern due to rapid deterioration of patient's status (Meynard, 1961). Currently, medical treatment of patients with traumatic bladder injuries is prioritized in most accidents and as an emergency intervention. The first priority is medical stabilization of the patient before reparative intervention is attempted, and treatment of associated life-threatening injuries (Lynch et al., 2003; Sura, 2011) to establish lack of an underlying cause for rupture, hypotonicity of the bladder, evidence of devitalization, urosepsis, and other reasons for celiotomy (Osborne and Sanderson, 1996). Nonsurgical management of traumatically ruptured urinary bladder has also been reported in children, resulting in a shorter hospital stay and equivalent outcome to those surgically managed (Osman and El-Tabey, 2005).

Urinary drainage and diversion is essential in treating urinary bladder trauma. Extraperitoneal ruptures can be managed safely in certain instances by simple catheter drainage (that is, urethral or suprapubic catheterization) and it should be left indwelling within the urinary bladder (Bartges and Polzin, 2011). After 3 to 5 days of catheterization, a contrast cystourethrogram is performed. If urinary leakage is still present, catheterization may be continued. An abdominal drainage catheter may also be used in conjunction with urethral catheter. Once cystourethrogram has proven that leakage has ceased, the catheters are removed and the animal is monitored for voluntary urination. All catheters should be submitted for bacterial culture at the time of removal, as the odds ratio for development of a urinary tract infection increases approximately 27% for each day of catheterization (Bubenik and Hosgood, 2007).

Virtually all extraperitoneal bladder injuries heal within three weeks, except in bladders with extensive extraperitoneal extravasation that often require surgical intervention (Jong et al., 2004). If catheterization is impossible (as in most cases of intraperitoneal bladder ruptures), drainage can be achieved via cystocentesis, cystostomy tube placement, or urinary bladder marsupialization (Bjorling, 1984). Cystostomy and marsupialization require general anesthesia; intermittent

cystocentesis may be preferred in the severely compromised animal (Bartges and Polzin, 2011). To address urine accumulation in the peritoneal cavity, a peritoneal catheter can be placed to lavage and evacuate it (McLoughlin, 2000). Most, if not all, intraperitoneal bladder ruptures require surgical exploration (where a midline celiotomy is performed, the defect in the bladder wall located, debrided, and closed with fine absorbable suture), because of the severity of associated injuries, and usually have a high mortality rate of 20 to 40% (Thomae et al., 1998; Awasum, 2010). Lacerations are usually large in these cases, with the potential risk of peritonitis due to urine leakage (leading to uoperitoneum and subsequent uoperitonitis) and infection if left untreated (Morey et al., 1999; Jong et al., 2004). All bladder perforations due to penetrating trauma should undergo emergency exploration and surgical repair (Morey et al., 1999).

BLUNT TRAUMA

Blunt trauma occurs when extensive external force exerted on the abdominal wall displaces the bladder to an unbearable elastic (stretch) limits such that the bladder wall gets weakened and sometimes may lead to tears. Blunt trauma injuries of the urinary bladder have been reported by Carroll and Mc Aninch (1984) to accounts for 67 to 86% of bladder ruptures, and may be classified as either extraperitoneal with leakage of urine limited to the perivesical space, or intraperitoneal, in which the peritoneal surface is being disrupted with concomitant urinary extravasation into the peritoneal cavity.

When extraperitoneal blunt trauma occurs as a consequence of blunt pelvic trauma resulting to lacerations or punctures due to bone fragment(s) and shearing of ligamentous attachment(s) due to pelvic and other long bone fractures (Dreitlein et al., 2001), the consequences are grievous. Intraperitoneal blunt trauma can occur due to high velocity blunt lower or caudal abdominal trauma and high intravesical pressure with rupture injuries at dome. It is characterized by high rate of associated intra-abdominal escape of urine and mortality (Dreitlein et al., 2001). These conditions are usually expressed with an exhibition of intense pain and haematuria. Unlike in penetrating urinary bladder trauma which makes diagnosis easier, blunt trauma injuries are often confused with medical causes of ascites or aetiologies of distended abdomen.

Diagnosis of blunt trauma or injury of urinary bladder is by multiple diagnostic procedures since it occurs in the context of multisystem trauma. This can be achieved by retrograde cystography, computed tomographic (CT) scan of the pelvis after retrograde instillation of bladder contrast, or during surgical exploration (Allen et al., 2001). Intraperitoneal bladder rupture can be handled by exploration and primary bladder closure or laparoscopic

repair (Gunnarsson and Heuman, 1997), while the extraperitoneal bladder injury is predominantly managed conservatively, with 2 weeks of indwelling Foley catheter drainage (Allen et al., 2001). Management of intraperitoneal bladder rupture (by exploration and primary bladder closure) has a lesser success rates compared to laparoscopic repair due to late presentation, lack of specialized equipments and diagnostic ability, length of hospital stay and infection risk (Suad et al., 2011).

PENETRATING TRAUMA

Penetrating trauma usually results from high-velocity gunshots or sharp stab wounds to the suprapubic area leading to direct injury to the bladder wall, and is commonly associated with injury to other organs (Dreitlein et al., 2001; Jong et al., 2004). Penetrating trauma tends to be more severe and less predictable than blunt trauma (Anonymous, 2009). Morey et al. (1999) suggested that, all bladder perforations resulting from penetrating trauma should undergo emergency exploration and repair.

IATROGENIC BLADDER INJURY

Due to intimate association of urinary bladder and other visceral organs, Christopher et al. (2011) reported that, iatrogenic bladder injuries are occasional complications of surgeries performed in the pelvis or caudal abdominal region, because of the close proximity of the bladder to the rectum in males and to the uterus in females. Thus, there is the potential for iatrogenic injury occurring during surgical dissection of the aforementioned structures. Iatrogenic bladder injuries that occur as complications in gynaecologic surgeries are of high incidence (Gambini et al., 2001; Dobrowolski et al., 2002) especially in ovarian cystectomy (Mteta et al., 2006), caesarean section, hysterectomy, hernioplasty, ovariohysterectomy, and other emergency surgeries close to the urinary bladder (Christopher et al., 2011).

Early diagnosis and repair offers the best outcome in the management of iatrogenic bladder injuries. Delayed diagnosis often leads to the development of local infection, which usually progresses to sepsis; thereby, complicating repair, impairing wound healing and producing poor outcomes (Gómez et al., 2004). Diagnosis involves cystography in which any discontinuity or disruption of the continuity of the bladder silhouette is positive for diagnosis of bladder rupture.

Ascending or retrograde contrast cystography is also advocated for this purpose. Continuous bladder drainage should however be maintained from repair until cystography confirms the integrity of the bladder repair. Perivesical drainage is recommended but should be removed after 48 h post-operatively unless there is bleeding

bleeding or extravasation of urine, which suggests an imperfect repair (Dobrowolski et al., 2002).

CONCLUSION

Lower urinary tract (bladder) trauma in small animals is one of the specialized and important injuries that can have significant consequences if not recognized early or left untreated. Recognizing and treating the injury can be difficult in a multitrauma patient. In general, when the index of suspicion is high, emergency intervention should be prioritized.

Conflict of interest

The authors declare that there is no conflict of interest.

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Full Length Research Paper

Cross-sectional study on bovine fasciolosis: prevalence, coprological, abattoir survey and financial loss due to liver condemnation at Areka Municipal Abattoir, Southern Ethiopia

Nebyou Moje^{1*}, Solomon Mathewos¹, Fanta Desissa² and Alemayehu Regassa¹

¹Hawassa University School of Veterinary Medicine, P.O. Box- 05, Hawassa, Ethiopia.

²Addis Ababa University, College of Veterinary Medicine and Agriculture, P. O. Box, 34, Bishoftu, Ethiopia.

Received 29 October, 2014; Accepted 4 December, 2014

A cross-sectional study was carried out from November 2013 to April 2014 on bovine fasciolosis at Areka municipal abattoir to estimate the prevalence of bovine fasciolosis, associated risk factors, evaluate the sensitivity of coprological test and estimate direct annual financial loss due to liver condemnation. From 400 sampled cattle's during the study period, 67 (16.75%) of their fecal samples and 120 (30%) of their livers were positive during antemortem and postmortem inspection, respectively. The prevalence of bovine fasciolosis was higher in older (>10 years [36.5%]) than younger ones (<5 years [20.8%]). The prevalence of bovine fasciolosis in study sites was significantly associated with age and body condition of cattle ($P < 0.05$). From species comparison, *Fasciola hepatica* (14.75%) was found to be the predominant species causing bovine fasciolosis. The direct financial analysis due to liver condemnation was made based on retail price/value of bovine liver and estimated to be 47,124 ETB (2,406.74 USD). In general, fasciolosis is more prevalent in the study area and cause loss in economic impact from liver condemnation. The fact of parasitic existence and associated economic loss warrant the need of control and prevention systems to be designed and implemented at the study site.

Key words: Areka municipal abattoir, bovine fasciolosis, coprology, liver condemnation, postmortem examination.

INTRODUCTION

Among many parasitic problems of farm animals, fasciolosis is a major disease, which imposes direct and indirect economic impact on livestock production, particularly of sheep and cattle (Keyyu et al., 2005; Menkir et

al., 2007). *Fasciola hepatica* and *Fasciola gigantica* are the two liver flukes commonly reported to cause fasciolosis in ruminants. The life cycle of these trematodes involves snail as an intermediate host (Walker

*Corresponding author. E-mail: nebmoje@yahoo.com. Tel: +251-910-248878.

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et al., 2008). Infected cattle can exhibit poor weight gain and dairy cattle have lower milk yield, and possibly metabolic diseases (Mason, 2004). Significant financial losses due to this parasite were recorded by different researchers at different sites of the globe like in United Kingdom and Ireland greater than 18 million Euros per year by Mulcahy and Dalton (2001), in Kenya 0.26 million USD per annum by Kithuka et al. (2002). In general, infection of domestic ruminants with *F. hepatica* and *F. gigantica* causes significant economic loss, estimated at over 200 million USD per annum to the agricultural sector worldwide, with over 600 million animals' infected (Ramajo et al., 2001). In addition to economic loss, another common dimension is added by the fact that several helminthes infections could be transmitted to man (Radostits et al., 2007; Chhabra and Singla, 2009).

In Ethiopia among many prevalent livestock diseases, parasitism in particular is one of the major entities exerting its direct and indirect effects to the economy of the nation. The two species of *Fasciola* (*F. gigantica* and *F. hepatica*) are found in different places of the country. The presence of these parasites in the country has a long history and is responsible for causing considerable losses in livestock production. Its prevalence and economical significance has been reported by several researchers in different parts of the country (Petros et al., 2013; Regassa et al., 2012; Miheretab et al., 2010; Manyzewal et al., 2014).

Even though different researchers in the country investigate the parasite, detail abattoir as well as coprological examination with their financial impact in southern part of the country specially, Areka area was very limited. With this, the current study was designed to determine the prevalence of fasciolosis and assessment of its direct economic impact due to both partial and total liver condemnation in slaughtered cattle of Areka municipal abattoir.

MATERIALS AND METHODS

Study area

The study was conducted from November, 2013 to April, 2014 in Areka municipal abattoir. Areka (also known as Areka Anchetu) is a town in southern part of Ethiopia, located in the Wolaita Zone of the Southern Nations, Nationalities and Peoples region, about 300 km southwest of the capital, Addis Ababa. This town has a latitude and longitude of 7°4'N37°42'E and in elevation of 1774 m above sea level. The rain fall pattern is bimodal, short rainy season which runs from March to May, followed by long rainy season which runs from June to September. Mean annual rain fall of Areka is about 1300 mm and the average annual temperature is 24°C. This town has an estimated total population of 22,277.

Study population

The study population was all cattle slaughtered at Areka municipal abattoir brought from Areka and its surrounding.

Study design and sampling method

A cross sectional study was used to determine the prevalence of bovine fasciolosis, and animals were selected with systematic random sampling method (after the first animal was selected randomly, then with equal interval while animals in larraige was selected) (Thrusfield, 1995).

Sample size determination

The sample size was determined by taking the prevalence of 47% (Abdul, 1992) fasciolosis using the formula given by Thrusfield (1995). Accordingly, 382 animals were supposed to be sampled; however, to increase the precision, 400 animals were sampled.

Experimental

Coprological examination

Fecal samples for parasitological examination were collected directly from the rectum of each animal and freshly defecated feces into plastic bottle with gloved hands. The samples were early labeled with universal bottles preserved with 5% formalin and each sample was clearly labeled with animal's identification and date. Samples were packed and dispatched into cool box to avoid the eggs developing and hatching, and were brought to Soddoo Veterinary Regional Laboratory. In the laboratory, coproscopic examination was performed to detect the presence of *Fasciola* eggs using the standard sedimentation techniques (Hansen and Perry, 1994).

Abattoir survey

Active abattoir survey was conducted based on cross-sectional study during routine meat inspection on systematically selected cattle slaughtered at Areka municipal abattoir. A total of 400 cattle were examined in the current study. During ante mortem examination, detail records about the ages, breeds, origin and body condition of animal were performed. The origin of animal was obtained from asking owners, while body condition scoring was based on Mari (1989). During postmortem inspection, each liver was inspected, palpated, and incised based on routine meat inspection (FAO, 2003). All organs having *Fasciola* species condemned were registered and flukes were collected for species identification.

Fasciola spp. identification

The liver of each study animal was carefully examined for the presence of lesions suggestive of *Fasciola* infection externally and sliced for confirmation. Liver flukes were recovered for differential count by cutting the infected liver into fine, approximately 1 cm slices with a sharp knife. Each mature fluke was identified to species level according to its shape and size. Investigation and identification of *Fasciola* was done according to their distinct morphological characteristics following the standard guidelines given by Urquhart et al. (1996).

Direct financial loss

Direct economic loss resulted from condemnation of liver affected by fasciolosis. All liver affected with fasciolosis were either partially or totally condemned depending on the severity of parasite distribution in the liver. The annual financial loss from liver condemnation

Table 1. Coprological and postmortem results of *Fasciola* in Areka municipal abattoir during the study period (n=400).

Result		No. of positive animals	Prevalence (%)
Coprology		67	16.75
	<i>F. gigantica</i>	20	5
Postmortem finding	<i>F. hepatica</i>	59	14.75
	Mixed (<i>F. gigantica</i> and <i>F. hepatica</i>)	41	10.25
Total		120	30

Table 2. Logistic regression analysis of the association of the prevalence with risk factors by coprology.

Risk factor		No. examined	No. positive (%)	Crude OR (95% CI)	AOR (95% CI)	P-value
Age (year)	≤5	77	13 (16.88)	1	1	
	5-10	197	33 (16.75)	1.01 (0.5, 2.2)	1.02 (0.5, 2.08)	0.963
	≥10	126	21 (16.67)	1.02 (0.47, 2.2)	1.04 (0.48, 2.25)	0.924
Breed	Local	351	57 (16.24)	1	1	
	Cross	49	10 (20.41)	1.32 (0.62, 2.8)	1.46 (0.67, 3.16)	0.337
BCS	Poor	52	14 (26.92)	1	1	
	Moderate	120	25 (20.83)	1.4 (0.66, 2.94)	1.4 (0.67, 3.1)	0.358
	Good	228	28 (12.28)	2.63 (1.3, 5)	2.78 (1.33, 5.88)	0.007

was assessed by considering the overall annually slaughtered animals of the abattoir and average retail market price of liver from butcheries in Areka town. Annual slaughtered rate was estimated from retrospective abattoir records. The information obtained was subjected to mathematical formula set by Ogunrinade and Adegoke (1982).

$$ALC = CSR \times LC \times P$$

where ALC is the annual loss from liver condemnation, LC is the mean cost of a liver in Areka town, CSR is the mean annual slaughtered at Areka municipal abattoir, P is the prevalence rate of disease at the study abattoir.

Data management and analysis

Data was stored in Microsoft Excel spread sheet program and was analyzed using intercooled STATA Version 11 for windows (2007) to determine the prevalence and the association with risk factors. The statistical method used was descriptive statistics. Body condition, age and breed were considered as potential risk factors for the prevalence of the diseases.

RESULTS

Prevalence

From 400 animals selected during study period, 67 (16.75%) animal fecal samples were positive for *Fasciola* eggs under coproscopic examination, whereas 120 (30%)

of livers were found to be positive for *Fasciola* during detail postmortem inspection (Table 1).

Coproscopic findings

From 400 animal feces sampled, proportional positive results were detected between different age groups (16.88, 16.75 and 16.67% in <5, 5-10 and >10 years old cattle). More cross breeds (20.41%) were found positive for coproscopic finding than local (16.24%). The other risk factors were body score condition (BCS) in which fecal sample from animals with poor BCS (26.92%) were found to be higher positive values in coproscopic (egg) examination than in good BCS (12.28%). Statistical analysis showed that BCS was statistically associated with the existence of parasitic egg ($p = 0.007$) (Table 2).

Abattoir survey

Among the 400 livers inspected during postmortem inspection, 120 (30%) were found to be positive for liver fluke. Out of this, a dominant liver were infected with *F. hepatica* 59 (14.75%) followed by mixed infection of both (*F. gigantica* and *F. hepatica*) 41 (10.25%) and *F. gigantica* 20 (5%). Moreover, those identified species were correlated with different risk factors. In relation to age of the animals, the prevalence was higher in those

Table 3. Abattoir prevalence of bovine fasciolosis proportion with risk factors.

Risk factor	No. examined	No. positive	Prevalence	FG (%)	FH (%)	Mixed (%)	Crude OR (95% CI)	AOR(95%CI)	P-value	
Age (year)	<5	77	16	20.8	4 (5.19)	7 (9.09)	5 (6.49)	1	1	
	5-10	197	58	29.4	12 (6.09)	32 (16.24)	14 (7.11)	1.59 (0.85, 2.99)	1.75 (0.91, 3.39)	0.096
	>10	126	46	36.5	4 (3.17)	20 (15.07)	22 (17.47)	2.19 (1.13, 4.24)	2.55 (1.27, 5.12)	0.008
Breed	Local	351	101	28.8	17 (4.84)	50 (14.25)	34 (9.69)	1	1	
	Cross	49	19	38.8	3 (6.12)	9 (18.37)	7 (14.29)	1.57 (0.84, 2.91)	1.79 (0.92, 3.5)	0.089
	Poor	52	28	53.8	5 (9.62)	15 (28.85)	8 (15.38)	1	1	
BCS	Moderate	120	48	40	6 (5)	25 (20.85)	17 (14.17)	1.67 (0.91, 3.33)	1.85 (0.9, 3.57)	0.078
	Good	228	44	19.3	9 (3.95)	19 (8.33)	16 (7.02)	5 (2.5, 10)	5 (2.86, 10)	0.000

FG: *Fasciola gigantica*, FH: *Fasciola hepatica*, AOR: Adjusted odds ratio.

animals with age of ≥ 10 years than in those with age 5 to 10 and ≤ 5 years with the prevalences of 36.51, 29.44, and 20%, respectively. In cases of breeds, prevalence were higher in cross (38.78%) than local breed (28.77%). The other risk factors were body condition score, in which poor body condition score animal livers (54.9%) were infected dominantly followed by moderate (40%) and good body (19.3%) conditioned animal livers, respectively. Furthermore, the analysis showed significant differences among different age groups and body condition scores of animals ($P < 0.05$) (Table 3).

There were no fecal samples of examined animals found to be positive in coproscopic examination as well as negative for postmortem inspection in liver inspection. These showed that postmortem examination was the golden test for diagnosis of fasciolosis when compared with coprology. The sensitivity and the specificity of fecal examination were found to be 55.8 and 100%, respectively. The calculated Kappa value (kappa = 0.6) indicated the presence of moderate agreements between the two techniques (Table 4).

Direct financial loss assessment

Generally, all livers with fasciolosis were to be condemned proportionally (either partially or totally) which are unfit for human consumption. During financial analysis, partially trimmed organs were taken and calculated in kilograms. From 120 infected livers of cattle, 89.75 livers were condemned due to fasciolosis (Weight of one bovine liver = 5 and 1 kg of liver = 14 ETB/0.7 USD) (Table 5).

In the current abattoir, the average annual cattle slaughtered were calculated from retrospective record and found to be 3,000, while average retail price of liver in Areka town was 70 ETB (3.58 USD). To estimate annual abattoir loss due to liver condemnation, a formula derived by Ogunrinade and Adegoke (1982) of Nigeria was adapted. But in this study, partial condemnation got attention and approximated in terms of numerical value of livers, that is, 163.75 kg of livers. So 163.75 kg of livers were found to be condemned partially and 285 kg of liver were found to be condemned totally for annual loss calculation, it was converted by considering

average kilogram of individual livers (One average weight of bovine liver = 5 kg). Therefore, the estimated annual abattoir loss due to liver condemnation was 47,124 ETB (2406.74 USD) (Current exchange of 1 USD = 19.58 ETB).

DISCUSSION

Bovine fasciolosis exists in almost all region of Ethiopia with its economic effects due to indirect causes, while it is in host related to production loss and the direct loss is associated with affected organs condemnation. The prevalence of fasciolosis observed in this study was 30% which appear to be higher than the prevalence's recorded by Gebretsadik et al. (2009) (24.3%) at Mekele area, Northern Ethiopia, Regassa et al. (2012) (21.9%) in Bishoftu Central Ethiopia and Petros et al. (2013) (21.6%) in Nekemte Western Ethiopia. However, the current finding was lower than that of Yilma and Mesfin (2000) (91%), Abebe et al. (2011) (53.7%), Manyazewal et al. (2014) (47.1%) and Phiri et al. (2005) (53.9%), at Northwest, Southwest Ethiopia and Zambia,

Table 4. Specificity, sensitivity of coproscopy and post mortem finding.

Parameter	Postmortem positive	Postmortem negative	Total
Coprology positive	67	0	67
Coprology negative	53	280	333
Total	120	280	400

Table 5. Economic loss assessment for liver condemnation.

Judgment in ratio	No. Positive	Condemned organs (number)	Condemned organs (kg)	Estimated economic loss in ETB/USD
T. condemned (1)	57	57	285	3990/203.78
P. condemned (3/4)	23	17.25	86.25	1207.5/61.67
P. condemned (1/2)	22	11	55	770/39.33
P. condemned (1/4)	18	4.5	22.5	315/16.09
Total	120	89.75	448.75	6282.5/320.86

T.: Totally, P.: Partially.

respectively. The significant variation in the prevalence of fasciolosis was mainly attributable to the variation in the climatic and ecological conditions such as altitude, rainfall, and temperature as well as the livestock management system among the study areas. On the other hand, the current result was in agreement with the findings of Mulat et al. (2012) (29.6%) and Miheretab et al. (2010) (32.3%) in Adwa, Northern Ethiopia.

In relation to risk factors, there was a significant difference in the infection rate ($P < 0.05$) among the age > 10 years ($p = 0.008$, $OR = 2.55$, $CI (1.27, 5.12)$) and good body scores condition (BSC) groups ($p = 0.00$, $OR = 5$, $CI (2.86, 10)$) in their postmortem findings. In support of this finding, a study conducted in Adwa by Miheretab et al. (2010) and in Mekelle by Yohannes (2008) indicated that the association between the prevalence of fasciolosis and body condition of the animals was also statistically significant. This could be due to the fact that animals with poor body condition are usually less resistant and are consequently susceptible to infectious diseases.

Species identification revealed that *F. hepatica* was more prevalent (14.75%) followed by mixed infestation (10.25%) and *F. gigantica* (5%). The predominant species involved in causing bovine fasciolosis in the study area was *F. hepatica* and is associated to the existence of favorable ecological condition for *Ligia truncatula* (intermediate host) of *F. hepatica* in the study area such as swampy and marshy area around Areka and different parts of the region, low lying plain and shallow pond provide favorable habitat for *L. truncatula* and allow the existence of *F. hepatica* in the area. The lower prevalence of *F. gigantica* was due to the unfavorable condition to the existence and multiplication of snail *Ligia natalensis* in the study area. The favorable condition for *L. natalensis* was border of lakes, flood prone area and

low lying marshy and drainage ditches for favorable habitat (Troncy, 1989).

The direct economic loss incurred during this study as a result of liver condemnation of cattle was estimated about 47,124 ETB/2,406.74 USD per annum. This result was found to be lower than the findings of Manyzewal et al. (2014) (47,570 ETB) and Petros et al. (2013) (63,072 ETB) at Mettu and Nekemte abattoirs, respectively. The existed variation might be correlated with slaughter capacity and number of condemned organs at those specific areas.

CONCLUSION AND RECOMMENDATION

The present study conducted on bovine fasciolosis in Areka municipal abattoir, Southern Ethiopia indicate that fasciolosis has been one of the major constraints to the livestock development in the area by inflicting remarkable direct economic losses.

The risk of socio-economic impacts of the parasite was required to implement systematic disease prevention and control methods.

ACKNOWLEDGEMENTS

The authors would like to thank Hawassa University for sponsoring this work and grateful to Areka Municipal Abattoir as well as Sodo Regional Veterinary Diagnostic Laboratory for allowing us to use their facilities.

Conflict of interest

The authors declare that there is no conflict of interest.

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