Prevalence of Gross Pathological Lung Lesions of Slaughtered Ruminants in Bishoftu Elfora Export Abattoir, Ethiopia

[1]Muluken Aychilu, [2]Fikadu Alemu and [1]Meskerem Adamu Chere

[1]Health Biotechnology Directorate,
Bio and Emerging Technology Institute, Addis Ababa, Ethiopia
[2]Department of Veterinary Microbiology and Public Health,
College of Veterinary Medicine, JigJiga University, JigJiga, Ethiopia

Abstract: Pulmonary diseases like pneumonia and hydatidosis, are among the most important notifiable disease conditions. A cross-sectional study was conducted from November 2017 to April 2018 with the objective of estimating the prevalence of major gross lung lesions in slaughtered ruminants at Bishoftu, Elfora Export Abattoir. A total of 1, 152 ruminants (384 cattle, 384 sheep and 384 goats) were examined before and after slaughter. Association between lung lesions and risk factors was estimated using the Chi-square test. The overall prevalence of pulmonary pathological lesion in ruminants was 58.3% which was 78.9%, 55.2% and 40.8% in cattle, sheep and goats, respectively. The gross pathological pulmonary lesions were further characterized as pneumonia, congestion, emphysema, hydatidosis, calcification, hemorrhage, atelectasis, abscess and pleural adhesion. The occurrence of pneumonia was significantly higher ($P<0.01$) in sheep compared to that in cattle and goats. A significantly higher prevalence of congestion ($P<0.01$), hydatidosis ($P<0.01$) and lung calcification ($P<0.02$ was recorded in cattle. Pulmonary lesions were significantly higher ($P<0.05$) in the older cattle than in the younger cattle. Pneumonia was the major lung pathology in sheep while the major lesions identified in cattle were congestion and hydatidosis. The gross lesion findings of the lung are important for controlling the transmission of zoonotic diseases.

Key words: Abattoir · Associated Risk Factors · Gross Lung Lesions · Cattle · Sheep · Goats

INTRODUCTION

Livestock systems contribute about 30 percent of the agricultural gross domestic product in developing countries [1]. In sub-Saharan African countries, livestock plays a significant role both in the national economy and the livelihood of rural communities [2]. Africa has a population of 205 million sheep and 174 million goats representing approximately 17% and 31% of the world's total, respectively [3]. Ethiopia owns a huge number of small ruminants, about 40 million sheep and 51 million goats [4]. Sheep and goats cover more than 30% of all domestic meat consumption and generate cash income from the export of meat, edible organs, live animals and skins [5]. Out of the population of livestock found in Ethiopia, the population of cattle is estimated to be 65 million [4]. Although the economic contribution of

livestock fluctuates from year to year, this sub-sector contributed 45% of agricultural Gross Domestic Product (GDP) in 2008/09 in Ethiopia [6]. However, Meat inspection, comprising of ante-mortem and post-mortem examination, can be used to prevent the distribution of contaminated meat that could result in disease risk for man and animals and, assist in the detection and eradication of certain diseases in livestock. Post-mortem inspection is also important to control meat hygiene since it provides essential information for the evaluation of clinical signs and pathological processes that affect the wholesomeness of meat [7]. Pulmonary diseases like tuberculosis, pneumonia, hydatidosis and lungworms are among the most dangerous diseases that cause rejection of organs and public health problems [8]. As a result, if such information had been assessed, it will aid in developing strategies to control the disease of animals

Corresponding Author: Muluken Aychilu, Health Biotechnology Directorate, Bio and Emerging Technology Institute, Addis Ababa, Ethiopia, Tel: +251946710259.

and humans in the country. Abattoir meat inspection is also necessary to know the extent to which the public is exposed to zoonotic diseases [9]. In addition to many municipal abattoirs in Ethiopia; currently, different modern export abattoirs like Ashiraf, Helmix, Elfora, Organic, Metehara, Mojo, Luna and Akaki have been established in different parts of the country. Even though the lung is not exported for the international market and is not commonly used for local human consumption, it can be affected by many disease-causing pathogens that can transmit different zoonotic diseases. The resulting pattern of diseases is determined largely by the structural and functional complexity of the system. The gross lesion findings of the lung are important to break the transmission cycle of different zoonotic diseases and to take appropriate measurements for the prevention and control of zoonotic diseases. Because of the public health problems due to zoonotic diseases like tuberculosis and hydatidosis, there are few reports on the prevalence of major gross pathological pulmonary lesions and their associated risk factors among cattle, sheep and goats. Therefore, the objective of the present study was to estimate the prevalence of major gross pathological pulmonary lesions and to identify the associated risk factors among cattle, sheep and goats slaughtered at Bisoftu Elfora Export Abattoir, Ethiopia.

MATERIALS AND METHODS

Study Area: This study was conducted from November 2017 to April 2018 in Elfora Export Abattoir, Bishoftu town. Bishoftu (Debre Zeit) is located 47.9 km South-east of Addis Ababa, the town is located in the East Shewa Zone of the Oromia Region and has a midland climate with an altitude of 1, 920 meters above sea level. The average annual rainfall and average maximum and minimum temperature for the area are 800mm, 27.7°C and 12.3°C respectively.

Study Animals: A total of 1, 152 ruminants (384 cattle, 384 sheep and 384 goats) were used to collect data. Animals were purchased for slaughtering purposes from different parts of the country. Animals were transported to the abattoir using vehicles. The majority of the animals principally originated from areas where animals are allowed to graze freely and housed in poorly constructed barns which is the dominant husbandry practice in the country. Some of the animals came from small-scale

intensive farms. Each of the study animals was ear-tagged with carton identification numbers and recorded accordingly on a format prepared for this purpose.

Study Design: This cross-sectional study was conducted to determine the prevalence of pulmonary lesions and associated risk factors in cattle, sheep and goats slaughtered at Bishoftu Elfora Export Abattoir using systematic random sampling techniques. Samples were collected every three days per week for cattle and every day for sheep & goats one day before slaughter, on the next day, data was collected from the lung of the corresponding ear-tagged animal after slaughter. Antemortem and postmortem examinations were made and data were recorded from each individual slaughtered animal.

Sample Size Determination: The sample size for the study was calculated according to the formula given by Thrusfeild [10], with a 95% confidence interval and at 5% desired absolute precision. Assuming 96.6% average prevalence of gross pathological pulmonary lesions for cattle and 18% for sheep and goats in ELFORA Export Abattoir. Data were collected from a total of 1, 152 ruminants (384 cattle, 384 sheep and 384 goats) using a systematic random sampling method.

Abattoir Survey
Antemortem Examination: Both ante-mortem and post-mortem inspections were carried out in accordance with the procedures of EMAMIR [11]. During ante mortem inspection, pre-slaughter examinations of ruminants were conducted at lairage and various information including age; body condition score and origin of each study animal was properly recorded. Cattle were grouped into young (3 to 6 years), adult (6-8years) and old (>8years) based on the theorem of dental eruption pattern described by Pace and Wakeman [12]. The body condition of animals had been also taken as a medium and good on the basis of body condition scoring guidelines of zebu cattle described by Nicholson and Butterworth [13]. Small ruminants, with erupted permanent incisor teeth and one pair of permanent incisors i.e. <1 year to 1½ years (for sheep) and <1 year to 2 years (for goats) were grouped as young. Those having two pairs and above permanent teeth ($\geq$1½ years (for sheep) and $\geq$2 years (for goats) were grouped as an adult. Body condition scoring was carried out based on the handbook given by

ESGPIP [14]. Scores were classified into six categories namely very thin (1), thin (2), moderate (3), fat (4) and very fat (5). For the convenience method, these categories were summarized into three classes poor (1), medium (2 and 3) and good (4 and 5). Additionally, any signs of diseases and abnormality were registered according to the standard antemortem inspection procedures and animals that were fit for human consumption were allowed for slaughter [15].

Post Mortem Inspection: During postmortem inspection, lungs were thoroughly inspected by visualization, palpation and making systemic incisions for the presence of cysts, emphysema, congestion, parasites and other abnormalities. Pathological lesions were differentiated and judged according to the guidelines on meat inspection for developing countries described by Herenda [7]. The results were recorded and the decisions were classified as totally approved and totally condemned.

Data Analysis: The collected data were stored in a Microsoft Excel spreadsheet for statistical analysis and were analyzed using Stata version 11 to estimate the prevalence of gross lesions and to assess the associated risk factors. Prevalence of pulmonary lesion was defined as the proportion of lung lesion in ruminants to the total number of ruminants examined. Association between the risk factors and pulmonary lesions in slaughtered ruminants was determined using the Chi-square test. P-value <0.05 was considered significant.

RESULTS

Ante-Mortem Findings: Out of 1, 152 ruminants, 158 of them showed different abnormalities such as skin damage, coughing, nasal discharge and depression. Out of the detected abnormalities, coughing, nasal discharge and depression were detected in 19.79% of sheep and 17.96% of goats. However, no anomalies were detected except skins damage in 3.4% of the cattle during antemortem inspection (Table 1).

Postmortem Finding: All animals that had been examined by the ante-mortem inspection were also subjected to postmortem examination. Out of 1152 lungs diagnosed with the gross lesion, the overall prevalence of pulmonary pathological lesion in ruminants was 58.3% and from a total of 384 cattle, 384 sheep and 384 goats' lungs, 78.9%, 55.2% and 40.8% were found to be positive for pulmonary pathological lesions during the gross examination, respectively (Table 2).

Gross pathological pulmonary lesions were further characterized by various specific pulmonary lesions such as pneumonia Figure 1, (C) and Figure 2, (D), congestion, emphysema Figure 2, (C), hydatidosis Figure 1, (A and B), calcification Figure 2, (B), hemorrhage Figure 1, (D), atelectasis, abscess Figure 2, (A) and pleural adhesion. These pulmonary lesions were presented in single or multiple lesions including pneumonia with abscess, congestion with hemorrhage and emphysema, hydatidosis with calcification, pneumonia with abscess and adhesion to pleura.

The prevalence of pneumonia among cattle, sheep and goats was 29.7%, 41.4% and 28.9%, respectively. Among the three species of ruminants, the occurrence of pneumonia was significantly higher (P<0.01) in sheep compared to cattle and goats. A significant difference (P<0.01) was also found in the prevalence of congestion among ruminants, about 37.2% of the cattle showed pulmonary congestion; however, congestion was absent in sheep and goats. A statistically significant difference was recorded in the prevalence of hydatidosis among ruminants. Hydatidosis was significantly higher (P<0.01) in cattle 15.4%, compared to that of sheep 1.82% and goats1.56%. Lung calcification in cattle (6.25%) was also significantly higher (P<0.02) compared to 3.38% in sheep and 2.6% in goats. Other described lesions such as hemorrhage, atelectasis, abscess and pleural adhesion, did not vary among ruminants (P>0.05). Multiple lung lesions in cattle (25.5%) are significantly higher (P<0.01) compared to that of sheep 4.94% and goats 6.25% (Table 3).

Prevalence of Pulmonary Lesions with Respect to Associated Factors: The prevalence of pulmonary lesions in cattle and sheep varies with respect to age however, no statistically significant difference (P>0.05) was recorded regarding their body condition and their origins. Among grossly inspected cattle grouped by age, the occurrence of pulmonary lesions was significantly higher (P<0.05) in cattle with old age (88.3%), followed by those of medium (79.4%) and young age (70.8%). A significantly higher (P<0.03) prevalence of pulmonary lesions was also observed in sheep of young age (58.8%) compared to sheep of old age (47%). The prevalence of pulmonary lesions did not vary by age factor and origins of goat. However, Goats with different body conditions had different pulmonary lesions. A higher prevalence of pulmonary lesions (80.3%) was recorded in a goat having medium body condition than that in (22.5%) with good body condition (Table 4).

Table 1: Abnormalities identified during the antemortem inspection

	Cattle n=384		Sheep n=384		Goat n=384	
Abnormalities	Positive	% Positive	Positive	% Positive	Positive	% Positive
Skins damage	13	3.38	0	0	0	0
Coughing	0	0	22	5.72	17	4.4
Nasal discharge	0	0	28	7.29	27	7
Depression	0	0	26	6.77	25	6.5
Total	13	3.38	76	19.79	69	17.9

Table 2: The overall prevalence of gross pulmonary pathological lesions in different species of ruminants slaughtered at ELFORA Export Abattoir

Species	No. examined	Positive	% Positive
Cattle	384	303	78.9
Sheep	384	212	55.2
Goat	384	157	40.8
Total	1152	672	58.3

Table 3: Types of pulmonary pathological lesions in different species of ruminants based on gross examination

		Ruminant species with lung lesions							
		Cattle (303)		Sheep (212)		Goat (157)		Positive ruminants		
		Prevalence							
No. of examined	Pathological lesions	No.	%	No.	%	No.	%	Number	Percent	P-value
1,152	Pneumonia	114	29.68	159	41.4	111	28.9	384	33.3	P=0.00
	Congestion	143	37.2	0	0	0	0	143	12.4	P=0.00
	Emphysema	22	5.7	14	3.64	17	4.42	53	4.6	P=0.37
	Hydatidosis	59	15.4	7	1.82	6	1.56	72	6.25	P=0.00
	Calcification	24	6.25	13	3.38	10	2.6	47	4.07	P=0.02
	Hemorrhage	26	6.8	15	3.9	17	4.42	58	5.03	P=0.154
	Atelectasis	10	2.6	7	1.82	7	1.82	24	2.08	P=0.682
	Abscess	11	2.86	14	3.64	15	3.9	40	3.47	P=0.714
	Adhesion	1	0.26	3	0.78	2	0.52	6	0.52	P=0.60
	Multiple lung lesions	98	25.5	19	4.94	24	6.25	141	12.23	P=0.00

Table 4: Risk factors associated with gross pathological lesions of lung ruminants

| Species	Risk Factors	Variables	No. Examined	No. positive	% Positive	P-Value
Cattle	Age	<6year	130	92	70.76	0.005
		6-8year	151	120	79.4	
		>8year	103	91	88.3	
	Body condition	Good	207	168	81.1	0.242
		Medium	177	135	76.2	
	Origin	N .west	189	156	82.5	0.228
		Central	36	27	75	
		east	159	120	75.47	
Sheep	Age	<1yearto1½ years	267	157	58.8	0.032
		.≥1½ years	117	55	47	
	Body condition	Good	282	159	56.38	0.442
		Medium	102	53	51.9	
	Origin	Poor	384	212	55.2	_
Goat	Age	<1 year to 2 years	285	144	50.5	0.549
		>2year	99	43	43.4	
	Body condition	Good	262	59	22.5	0.00
		Medium	122	98	80.3	
	Origin	N. western	89	34	38.2	0.812
		Central	158	67	42.4	
		Southern	137	56	40.8	
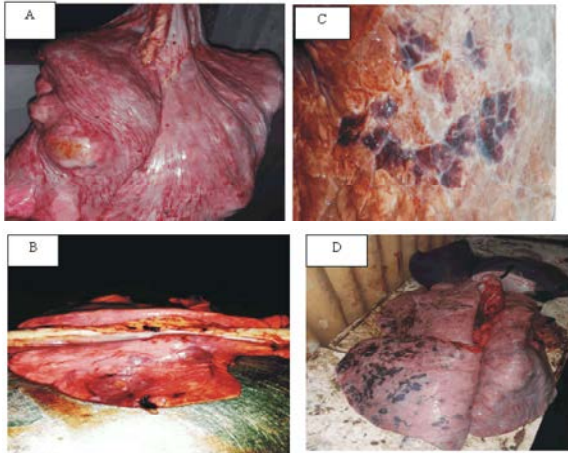
Fig. 1: Lung pathologies of cattle slaughtered at Elfora Export Abattoir, Bishoftu, Ethiopia. (A and B) Hydatid cysts; (C) Marble appearance of contagious bovine pleuropneumonia (CBPP); (D) hemorrhage

Fig. 2: Lung pathologies of goats and sheep slaughtered at Elfora Export Abattoir, Bishoftu, Ethiopia. (A) Abscess in goats; (B) Calcification in sheep; (C) Emphysema in sheep; (D) pneumonia in sheep

DISCUSSION

Abattoir meat inspection and slaughter records contribute to disease surveillance and control through macroscopic identification and recording of basic lesions, thus it is a first step in monitoring diseases in the national herd and flock. The information received through surveillance studies provides feedback to the veterinary service for the control and eradication of animal diseases and for the protection of the public from zoonotic hazards [16].

The current prevalence of pulmonary lesions in cattle (58.3%), was lower than the finding of Abayneh [17] who found a higher prevalence of 83.87% in Asella Abattoir, Ethiopia. However, it was higher than the previous reports of other authors [18-21].

The prevalence of pulmonary lesions in sheep (55.2%) and in goats (40.9%) in this study, was higher than those previously documented reports by different authors [22-23]. Pulmonary lesions may occur due to inappropriate slaughtering processes such as inefficient bleeding, stress factors during transportation of animals, exposure to dust, poor management system and environmental conditions and other risk factors, animals' body condition, age differences, infections and parasites, etc. Animals with poor body conditions might be affected by poor nutrition, parasites, or other diseases. Therefore, the variations in pulmonary lesions results of various researchers may differ depending on the type and presence of risk factors.

The prevalence of cattle pneumonia (29.29%) in the present study was in agreement with the previous reports of other authors [24-25]. However, it was lower than the prevalence reported by Fekadu *et al*. [26] and Kambarage [27]. Among the three species of ruminants, the occurrence of pneumonia was significantly higher in sheep (41.4%) compared to that of cattle and goats. In addition, the current prevalence of pneumonia in the lungs of sheep and goats was higher than those previously indicated by other authors [22, 23, 28]. Pneumonia may affect stressed animals that are transported long distances to the abattoir, transportation stress and starvation, endemic diseases such as pasteurellosis and animals having traumatically penetrated lungs, suffocation of animals due to over-crowding in the lairages, lack of enough rest before slaughter and exposure to bacterial and/or viral infections may lead to the development of emphysema and pneumonia [18].

Based on gross examination of ruminant lungs, the prevalence of congestion was found to be higher, (37.2%) in cattle and it was not detected in the lungs of sheep and goats. The current prevalence rate of pulmonary congestion in cattle was higher than the previous studies reported by Enyew *et al*. [29] and Tesfaheywet and Biruk [30] who reported 8.8% from Gonder Elfora Export Abattoir and 18.1% from Hawassa Municipal Abattoir, respectively.

Emphysema in cattle is typically associated with some primary respiratory disease conditions such as infectious bovine rhinotracheitis, pneumonic pasteurellosis, malignant catarrhal fever, mycoplasma

infection, leptospirosis and some cases of septicemia and endocarditis. Because of well-developed pulmonary interlobular septa and lack of collateral ventilation in sheep, pigs and particularly cattle, these species are susceptible to interstitial emphysema [31]. The current prevalence of emphysema in cattle (5.7%), was slightly similar to the report of Fekadu *et al.* [26], who indicated a 6.77% prevalence, but it was higher than the 1.2% shown by Fasil [32]. Then again it was lower than those reported by other authors [27, 29, 33-34]. The present prevalence of emphysema in sheep and goats is relatively similar to those reported by previous authors [22]. However, it was lower than those reported by Aynalem *et al.* [28].

In the present study, hydatidosis was one of the most frequent pulmonary lesions reported in cattle with a prevalence of (15.4%), which is similar to the reports of different authors [35]. However, it was higher than that indicated by Buzuayehu *et al.* [36] and it was lower than the reports of different authors [26, 37-38]. The prevalence of hydatidosis in sheep (1.82%) and goats (1.56%) was rare, this is similar to the reports of Aynalem *et al.* [28]. However, it was lower than the previous reports of different authors [39-41]. The variation in the prevalence of hydatidosis reported in different areas and times could be due to the differences in the management practices of ruminants, culture, social activity, grazing areas of the animals, presence of dog population, dog management as well as deworming practices, offal disposal habits and age of ruminants slaughtered and also awareness amongst farmers. Slaughtered ruminants at Bishoftu Elfora Abattoir were originated from different corners of the country and were reared with different management practices. In addition, the strain difference of *E. granulosus* that exists in different geographical situations might be also attributed to the prevalence variation.

Lungs and livers are major development sites of hydatid cysts because of that they possess the first great capillaries of sites encountered by migrating *E. oncospheres* (Hexacanth embryo) which adopt the portal vein route. The first large capillaries encountered by migrating blood-borne oncospheres primarily negotiate pulmonary and hepatic filtering systems sequentially before any other organ is involved [42]. Furthermore, the softer consistency of the lung tissue allows for the easier development of the cyst hence providing a good environment for the fertility of hydatid cyst [43].

The prevalence of lung calcification in cattle (6.25%) was also higher compared to that of sheep 3.38% and goats 2.6%. This prevalence in cattle was similar to that reported by Enyew *et al.* [29], however, it was higher than the reports of another author [30]. The current prevalence

of lung calcification in sheep and goats was in agreement with that indicated by Aynalem *et al.* [28]. But, it was slightly higher than the reports of another author [22]. Dystrophic calcifications occur in a damaged lung following an inflammatory process such as infection tuberculosis, pneumocystis, bleeding, or pulmonary infarction. It is a local, organized process with local deposition of calcium salt [44]. The prevalence of lung calcification in cattle might be associated with the presence of hydatidosis reported in the lung of cattle in the present study.

The prevalence of hemorrhagic lesions in the current study was 6.8%, 3.9% and 4.42% in cattle, sheep and goats, respectively. The current prevalence of hemorrhagic lesions in cattle (6.8%), was similar to the previous report [29], but it was higher than the 0.4% reported by Tesfaheywet and Biruk [30]. The current prevalence of ruminant atelectasis is minor. The prevalence of atelectasis in cattle (2.6%), is lower than 6.4% reported by Tesfaheywet and Biruk [30] and 5.1% reported by Enyew *et al.* [29]. This lung lesion might be resulted from the exposure of animals to stress factors like dust, overcrowding and exhaustion from long treks in search of pasture and water during the dry season which may also contribute to these respiratory conditions [45].

Accumulation of pus (abscessation) in the lungs indicates the presence of pyogenic bacteria and most often is because of secondary bacterial infection and poor immunity. This study also showed a lower prevalence of pulmonary abscess in ruminants. The current prevalence of abscess in cattle (2.86%), was lower than the reports of previous authors [29, 34, 46]. Then again, the prevalence of abscesses in sheep (3.63%) and goats (3.9%) was higher than those previously reported by Aynalem *et al.* [28].

Multiple lung lesions either pneumonia with abscess, congestion with hemorrhage and emphysema, hydatidosis with calcification, pneumonia with abscess and adhesion to pleura were presented in 25.5% of cattle, 4.94% of sheep and 6.25% of goats. This type of lesion appearance was higher in cattle than that of sheep and goats.

CONCLUSIONS AND RECOMMENDATION

The majority of identified ruminant lung lesions at Elfora Export Abattoir were insidious without clinical signs. There were significant age group differences in the prevalence of pulmonary lesions in cattle and sheep. The Prevalence of pulmonary lesions in cattle and sheep was not varied by the body conditions. Goats with different body conditions showed a significant difference

in the prevalence of pulmonary lesions. Among identified lung pathologies, pneumonia was the major lesion found in the lungs of slaughtered sheep while, the major lesions in cattle were congestion, hydatidosis and lung calcification. The presence of abscess and hydatidosis in this study indicates there is a public health concern. Therefore, it is very important to give special attention to awareness creation on animal management, zoonotic disease transmission and the monitoring and control measures of these diseases, to prevent public health hazards.

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