

PULMONARY LESIONS OF CATTLE AND ASSOCIATED FINANCIAL LOSSES AT THE BUTEMBO PUBLIC SLAUGHTERHOUSE IN DEMOCRATIC REPUBLIC OF CONGO

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ABSTRACT

A retrospective and active investigation was carried out with the aim of identifying the main pulmonary lesions which lead to the condemnation of the lung at the public slaughterhouse of Butembo in order to assess their economic implications. In the retrospective survey, a total of 20,755 bovine animals were collected from the slaughterhouse records from January 2016 to July 2017 and revealed a rate of 7.4 %. The lesions implicated were pulmonary aillotage, verminous bronchitis, tuberculosis, abscesses, congestion, edema, emphysema and petechial. The associated financial loss was 4,208,798/3,639.608 CDF (Congolese franc)/USD. The active survey (n = 768), carried out using the traditional method of meat inspection at the slaughterhouse from August to December 2017 revealed a condemnation rate of 10.66 % associated with a financial loss of 185,196.8/1,777.626 CDF/USD. Lesions found were verminous bronchitis, emphysema, pleurisy, pulmonary aillotage, congestion, hepatization, abscesses and petechial. Significant difference ($p < 0.01$) was determined between the different condemnation rates from the retrospective and active survey. This study determined that pulmonary aillotage, emphysema, edema, verminous bronchitis and abscesses and their associated financial losses as the main causes of condemnation of the lung at Butembo public slaughterhouse. The results of this study may be used as a basis for comparison for similar studies, provide insight into the epidemiology of respiratory diseases in livestock in the town of Butembo and insight into the extend of public exposure to certain zoonosis.

Keywords: Pulmonary lesions, Cattle, Financial loss, Butembo public slaughterhouse

INTRODUCTION

Meat is a high proteinous food of animal origin (Ugochukwu *et al.*, 2017). However, it can traditionally transmit many diseases to consumers (zoonosis) in the absence of meat and sanitary inspection at the slaughterhouse (Magras *et al.*, 2009; Stark *et al.*, 2014). During the meat inspection process, the veterinary

inspectors aim to detect all the lesions that may, on the one hand, make the meat likely to be harmful for human consumption (lesions specific to a pathology such as tuberculosis), on the other hand, lesions having an impact on the organoleptic quality of the meat (no specific lesions such as pulmonary labeling) (Dupuy *et al.*, 2014).

Consequently, the inspection information of meat, carcass and offal condemned as well as the reasons for their condemnations, associated with information on mortalities obtained from farmers make the slaughterhouse an important place for frequent surveillance of animal health (Deschamps *et al.*, 2013; Dupuy *et al.*, 2015). The slaughterhouse thus constitutes a privileged observatory laboratory for animal health (Baghban and Yaripour, 2016; Jaja *et al.*, 2016) and consequently, a valuable source of information needful for prophylactic program and also to improve epidemiological practices (Benhathat and Aggad, 2017).

These data may also indicated the extend of public exposure to certain zoonotic diseases such as tuberculosis, cysticercosis, hydatidosis and distomatosis as well as the economic losses associated with the condemnation of carcasses and offal (Jemal and Kebede, 2016).

In many European and Asian countries (Denmark, Sweden, Finland, France, etc.) data from slaughterhouses on reasons for condemnations of carcasses and offal, and its direct and indirect economic impact have been the subject of several studies (Dupuy *et al.*, 2014).

In African countries, such as Tanzania, Rwanda, Algeria and Ethiopia, the causes for condemnation offal and carcasses have been the subject of several studies (Mellau *et al.*, 2010; Habarugira *et al.*, 2016; Benhathat and Aggad, 2017; Belina and Melese, 2017). These authors reported variable lesions (specific and non-specific), the frequency of which depended on several factors related to agro ecology, slaughterhouses and livestock management.

However, there is a lack of such research in DRC in general and in the city of Butembo in particular, where no study to date has documented the substantial losses due to organ/lung condemnations at the slaughterhouse. These data would be useful in improving the epidemiologic insights of respiratory pathologies.

It is in this context that our objective has been to identify the main causes of lung condemnation and to assess the associated economic losses.

MATERIALS AND METHODS

Study Area: The study was carried out in Butembo town, located in the province of North Kivu in the North East of the DRC. It covers an area of approximately 190.30 km² with 744.838 inhabitants (Sahani, 2011). It is geographically located between latitudes 0° 05' and 0° 10' north and longitudes 29° 17' and 29° 18' east, and dominated by a humid subtropical climate tempered by mountains. The average temperature is 18°C with an average annual precipitation of 1,382 mm (Sahani, 2011). Koppen-Geiger in its classification places it in the Afi type (Sahani *et al.*, 2012). The town of Butembo has three private slaughterhouses and a public slaughterhouse where this study was carried out. The choice of this slaughterhouse was motivated by its greater daily slaughter rate, which was about 40 heads per day.

Study Animals: The animals in this study consisted of cattle of different breed and age from the different peripheral livestock areas of Butembo and largely (80 %) from Tanzania and Uganda.

The sample size was calculated according to the model proposed by Thrusfield (2018) based on an expected prevalence of 50 %, with a confidence interval of 95 % and a desired absolute precision of 5 %. $N = 1.96^2 \text{Pexp} (1 - \text{Pexp})/d^2$, where N = Sample size, Pexp = expected prevalence and d² = Absolute precision desired.

By introducing these elements into the formula the size of the active sample was initially 384 carcasses. However, this number was increased by the systematic random sampling procedure. This was very important in increasing the precision of the prevalence given the high number of animals slaughtered during the retrospective study. The retrospective survey lasted for 19 months, from January 2016 to July 2017. Sample units were selected at equal intervals with the first animal being chosen at random.

Therefore, the sampling interval was calculated by dividing the total number of animal slaughtered during the study period by the simple size (Jaja *et al.*, 2016).

The total number of animals slaughtered in the retrospective investigation obtained from slaughterhouse records was 20755 cattle. This retrospective survey covered the months of January 2016 to July 2017. The causes of lung condemnations were recorded and their economic implications determined.

The active survey was carried out from August to December 2017 during this investigation; the lungs of the selected carcasses were carefully treated following the usual meat inspection technique (inspection, palpation, and incision in several places). Lesions observed were differentiated and judged based on meat inspection procedures (Herenda *et al.*, 1994).

The lungs from each carcass included in the study were considered unfit for consumption and carefully collected in a condemnation bin. The lesions which led to total condemnations of the lung were collected daily for 5 months. The economic loss was estimated on the basis of the formula of Worku *et al.* (2017). $APC = CSR \times PC \times p$, where APC = annual loss due to condemnation of the lung, CSR = total number of animals slaughtered during the study period, PC = average price of 1 kg of lung and p = prevalence of lesions.

The price of 1 kg of the lung obtained from the market for the year 2016 was 2600 CDF, while for the year 2017 it was 3000 CDF. The CDF/USD exchange rate during the research period was variable 1061.84 CDF for 1 USD in 2016 and 1391.556 CDF for 1 USD in 2017.

Statistical Analysis: The data collected during this study were recorded in Microsoft Excel 2007. The condemnation rates were calculated using simple descriptive statistics of statistical analysis system and compared using chi-square test at a critical probability of $p < 0.01$.

RESULTS

Out of a total of 20,755 cattle slaughtered during retrospective survey, 1,543 cattle had lungs with pulmonary lesions (Table 1), while, during the active survey 82 cattle had lungs with pulmonary lesions out of a total of 768

cattle slaughtered (Table 2). The leading causes of lung condemnation were pulmonary aillotage (4.68 %) closely followed by emphysema (2.86 %), edema (0.91 %) and the lowest percentage of condemnation was because of verminous bronchitis (0.78 %) and abscess (0.52 %) (Table 2). Condemnation rate was 7.40 % and 10.66% respectively during the retrospective and active survey. Monetary loss associated with the condemned lung was 1,851,961.8 /1,177.63 CDF/USD for active survey (Table 2) and 4,208,798/3,639.61 CDF/USD for the retrospective survey (Table 3). The difference was significant ($p < 0.01$) between the rate of lungs condemnation (Table 4).

DISCUSSION

This study revealed a condemnation rate of 7.40 and 10.66 % respectively during the retrospective and active investigation. The rate found in the present study were lower than the lung condemnation rate of 86.20 % in slaughtered animals in Tigray, Ethiopia (Gebrehiwot *et al.*, 2015), 18.49 % in cattle slaughtered at Dessie municipal abattoir North Eastern Ethiopia (Tefera *et al.*, 2016) and 54.59 % reported in cattle slaughtered at Tiaret, Algeria (Benhathat and Aggad, 2017).

This variability in the condemnation rate observed in this study compared to those elsewhere may be associated to the agro-ecological effects of the different exploitation zones and to the different management and exploitation habits of animals. Furthermore, information from literature indicated that some diseases may be endemic to a specific agro-ecological zone where the causative agent and its intermediate host find favorable conditions (Gebrehiwot *et al.*, 2015).

The difference in temperature, humidity, hygrometry, feeding which remains variable depending on the operating zones can also influence the presence or the absence of diseases (Deschamps *et al.*, 2013; Belina and Melese, 2017). Pulmonary hydatidosis has been reported as the most implicated cause of lungs condemnation in many Ethiopian slaughterhouses (Jemal *et al.*, 2016).

Table 1: Causes of cattle lungs condemnation recorded during retrospective survey of the Butembo public slaughterhouse in Democratic Republic of Congo

Organ	Causes of condemnation	Year 2016 (n ₁ =13420)		Year 2017 (n ₂ =7335)		Total N=20755	
		NC	%	NC	%	NC	%
Lung	Pulmonary aillotage	747	5.6	369	5	1116	5.37
	Emphysema	255	1.9	96	1.3	351	1.69
	Abscess	20	0.15	3	0.04	23	0.11
	congestion	9	0.07	4	0.05	13	0.06
	Verminous bronchitis	12	0.1	3	0.04	15	0.07
	Petechiae	1	0.01	5	0.07	6	0.03
	Edemas	6	0.04	6	0.08	12	0.06
	Hépatization	3	0.02	2	0.02	5	0.02
	Tuberculosis	2	0.01	-	-	2	0.01
Total		1,055	7.90	488	6.60	1,543	7.40

Legend: N= Total number of animals slaughtered during retrospective survey, n₁=number of animals slaughtered from January to December 2016, n₂= number of animals slaughtered from January to July 2017, nc= number of lungs condemned

Table 2: Causes of cattle lungs condemnation and associated monetary loss during the active survey of the Butembo public slaughterhouse in Democratic Republic of Congo

Organ	Causes of condemnation	N ₁ =768		CDF	USD
		NC	%		
Lung	Pulmonary aillotage	36	4.68	813,056.40	517.03
	Emphysema	22	286	496,867.80	315.95
	Abscess	4	0.52	90,339.60	57.44
	Congestion	3	0.39	67,754.7	43.08
	Verminous bronchitis	6	0.78	135,509.40	86.17
	Petechiae	1	0.13	22,584.90	14.36
	Edemas	7	0.91	158,094.30	100.53
	Hepatisations	1	0.13	22,584.90	14.36
	Pleurisy	2	0.26	45,169.90	28.72
Total		82	10.66	1,851,961.80	1,177.63

Legend: N₁=total number of animals slaughtered during active survey, CDF= Congolese franc, USD = United State Dollar

Table 3: Monetary losses associated with lungs condemnation during retrospective survey of the Butembo public slaughterhouse in Democratic Republic of Congo

Variables	Year 2016	Year 2017	Total
Number of animals with pulmonary lesions	1,055	488	1,543.00
Losses in CDF	2,756,468.00	1,452,330.00	4,208,798.00
Losses in USD	2,595.93	1,043.67	3,639.61

Legend: CDF= Congolese franc, USD = United State Dollar

Table 4: Frequency of lungs condemned during retrospective and active survey of the Butembo public slaughterhouse in Democratic Republic of Congo

Lungs	Retrospective survey	Active survey	Total
Number of lungs condemned	1543(7.40)	82(10.60)	1625(7.55)
Number of lungs not condemned	9212(92.57)	686(82.30)	19898(92.45)
Total	20755(100.00)	768(100.00)	21523(100.00)

Number in parenthesis = percentage

The lesions responsible for the 10.66 % loss of lungs in this study were pulmonary aillotage, emphysema, abscesses, edema, congestion, verminous bronchitis, petechial, hepatization and pleurisy. Of these lesions pulmonary aillotage, emphysema, edema, verminous bronchitis and abscesses were found to be the most dominant causes of the lung condemnation.

The results of this study corroborated those of Gebrehiwot *et al.* (2015) and Jaja *et al.* (2016), who reported similar lesions in lungs of animals slaughtered in Ethiopia and South Africa respectively.

By comparing the condemnation rates induced by each lung lesion, the pulmonary aillotage resulted in loss of 4.70 % lungs. Occurrence of pulmonary aillotage may be due to improper ante-mortem examination and method of slaughtering the animals (bleeding in lateral decubitus) which lead to aspiration of blood during the phase of agony (Kane *et al.*, 2005).

Pulmonary emphysema is the second leading cause of lungs condemnation with a loss of 2.86 % lungs. This has been reported as the second cause of lung condemnation in Ethiopia (Gebrehiwot *et al.*, 2015) and Algeria (Benhathat and Aggad, 2017). Compared to other research, the percentage of condemnation of lung due to emphysema found in this study was higher than the percentage of 1.12 % reported in slaughtered cattle in the Eastern Cape Province, South Africa by Jaja *et al.* (2016), but lower than 9.5 % reported in cattle slaughtered at Gondar Elfora Abattoir, North West, Ethiopia by Mekuriaw *et al.* (2016) and 17.46 % reported in cattle slaughtered at Tiaret, Algeria by Benhathat and Aggad (2017). The higher rate of emphysema noted in this study would be associated to several stress factors such as exposure to dust from environment or exhaustion during long distance walk (Tefera *et al.*, 2016). However, some cases of emphysema have been recorded in abattoir because of extensive agonal phase gasping during slaughter especially when animals are slaughtered without captive bolt stunning (Mellau *et al.*, 2010). Moreover, emphysema can either be secondary to certain respiratory

pathologies: infectious bovine rhinotracheitis, malignant blue tongue, pasteurellosis or be linked to some case of sepsis and endocarditis (Blood *et al.*, 2007; Benhathat and Aggad, 2017). Edema, verminous bronchitis and abscesses were major lesions which resulted in losses of 0.90, 0.70 and 0.50 % lungs respectively. Considering the percentage of verminous bronchitis observed in this study, it was close to 1.0 % of lung reported by Jaja *et al.* (2016) but lower than 6.05 % reported by Benhathat and Aggad (2017). The prevalence of verminous bronchitis in this study may be linked to non-compliance with hygiene measures and deworming of the animals by some farmers. Furthermore, verminous bronchitis is a sporadic pathological disease of cattle of tropical and subtropical mountainous areas (Fitzpatrick, 2013). In this regard, the inflammation and allergy caused by migrating and feeding activity of these worms predispose the pulmonary parenchyma to edema. A loss rate off 0.90 % lungs due to pulmonary edema was observed in this study. Pulmonary edema may be secondary to other systemic pathologies (Blood *et al.*, 2007). However, the prevalence of pulmonary edema reported in this study was lower than that of Tefera *et al.* (2016) in Ethiopia.

In this study lung abscess resulted in loss of 0.50 %. This percentage found locally was lower than 2.60 % reported by Tefera *et al.* (2016) at Dessie municipal abattoir North Eastern Ethiopia, 19.20 %, reported by Dupuy *et al.* (2014) in France and 3.02 % reported by Benhathat and Aggad (2017) at Tiaret abattoir in Algeria. Pathogens such as *Pasteurella haemolytica* and *Actinomyces pyogenes* have been documented in Tanzania to cause lung abscess in cattle (Mellau *et al.*, 2010). Lung abscesses can also be caused from infected emboli in endocarditis, metritis and mastitis (Jaja *et al.*, 2016; Benhathat and Aggad, 2017).

Economic Loss due to Condemnation of the Lung: The retrospective survey revealed 7.4 % lungs condemned accounting for an estimated financial loss of 4208798 CDF, while the active had 10.66 % lungs condemned accounting for an estimated financial loss of 185196.8 CDF. Variable financial losses has been reported in many African countries due to the condemnation of organ and

carcasses, particularly in Tanzania (Mellau *et al.*, 2010), Algeria (Jaja *et al.*, 2016), Ethiopia (Belina and Melese, 2017) as well as in Europe (Dupuy *et al.*, 2014; Stark *et al.*, 2014).

These authors reported that many pathological and non-pathological factors can lead to organs and carcasses condemnation and thus cause financial loss which can affect the butcher, the farmer, the slaughterhouse and the city economy. The variations in economic losses may have been because of differences in slaughter capacity, prices of 1 kg of lung and monetary exchange rates. Financial losses associated with lungs condemnation have been reported in Tanzania (Mellau *et al.*, 2010) and Algeria (Jaja *et al.*, 2016).

Conclusion: The results of this study revealed a condemnation rate of 7.4 % and 10.66 % respectively during the retrospective and active investigation. These rates correspond to a financial loss of 4,208, 798/3,639.61 CDF/USD for the retrospective survey and 1,851,961.8/1,177.63 CDF/USD for the active survey. The major causes were pulmonary aillotage, emphysema, edema, verminous bronchitis and abscess. On the basis of these results further studies on: (i) the risks of carcasses condemnations in public slaughterhouse of Congo republic and (ii) the identification and epidemiological study of livestock pathologies and their effective control. There is need to encourage similar study in other cities of Democratic Republic of Congo.

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