Vol. 12(2), pp. 27-35, April-June 2020
DOI: 10.5897/JVMAH2019.0779
Article Number: E2EEFBF63595
ISSN: 2141-2529
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Journal of Veterinary Medicine and Animal Health

Full Length Research Paper

Causes of organ condemnations in cattle at slaughter and associated financial losses in Siaya County, Kenya

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Received 31 May, 2019; Accepted 18 September, 2019

Cattle production is an important economic activity worldwide. Its potential, however, is not fully maximized owing to disease conditions, some causing condemnation and wastage of edible organs at slaughter and a threat of zoonoses. This work aimed at establishing definitive causes of organ condemnation and financial losses in cattle from three slaughterhouses (Kaumara, Siaya, and Ugunja) in Siaya County, Kenya, through a cross-sectional study. Out of 112 cattle slaughtered, 75 (67%) had one or more organs condemned. Parasitic infestations [hepatic fasciolosis due to *Fasciola* infection 58 (51.8%), pimply guts/*Oesophagostomiasis* 28 (25%) and hepatic hydatidosis 1 (0.9%)], were major causes. Others were pulmonary blood aspiration from lack of stunning 2 (1.8%), inflammatory conditions [muscle abscess due to Corynebacterium pseudotuberculosis infection 1 (0.9%)] and splenomegaly [from congestion 1 (0.9%) and hemosiderosis 1 (0.9%)], consequently, 198 kg of edible meat amounting to Kenya Shillings. 94,470 (US$. 935) was lost. The study demonstrated that controllable parasitic and bacterial conditions, as well as poor slaughtering techniques, caused condemnation of the organs, leading to loss of edible organs for consumers and heavy economic losses to livestock farmers and traders. Additionally, the occurrence of hepatic fasciolosis and hydatidosis suggested a possible zoonotic risk. Sensitization of cattle farmers on measures of controlling the conditions at farm level and slaughterhouse workers towards proper slaughter techniques is recommended. Further research using methods such as molecular techniques is needed to determine possible zoonotic transmission.

Key words: Zoonotic conditions, post-mortem meat inspection, laboratory diagnosis, condemnation losses, Siaya County.

INTRODUCTION

There are more than 1.4 billion cattle around the world, generally kept for meat, milk and dairy products, hides, skins and for draught power (FAO, 2013). In Kenya, cattle production is one of the most important economic

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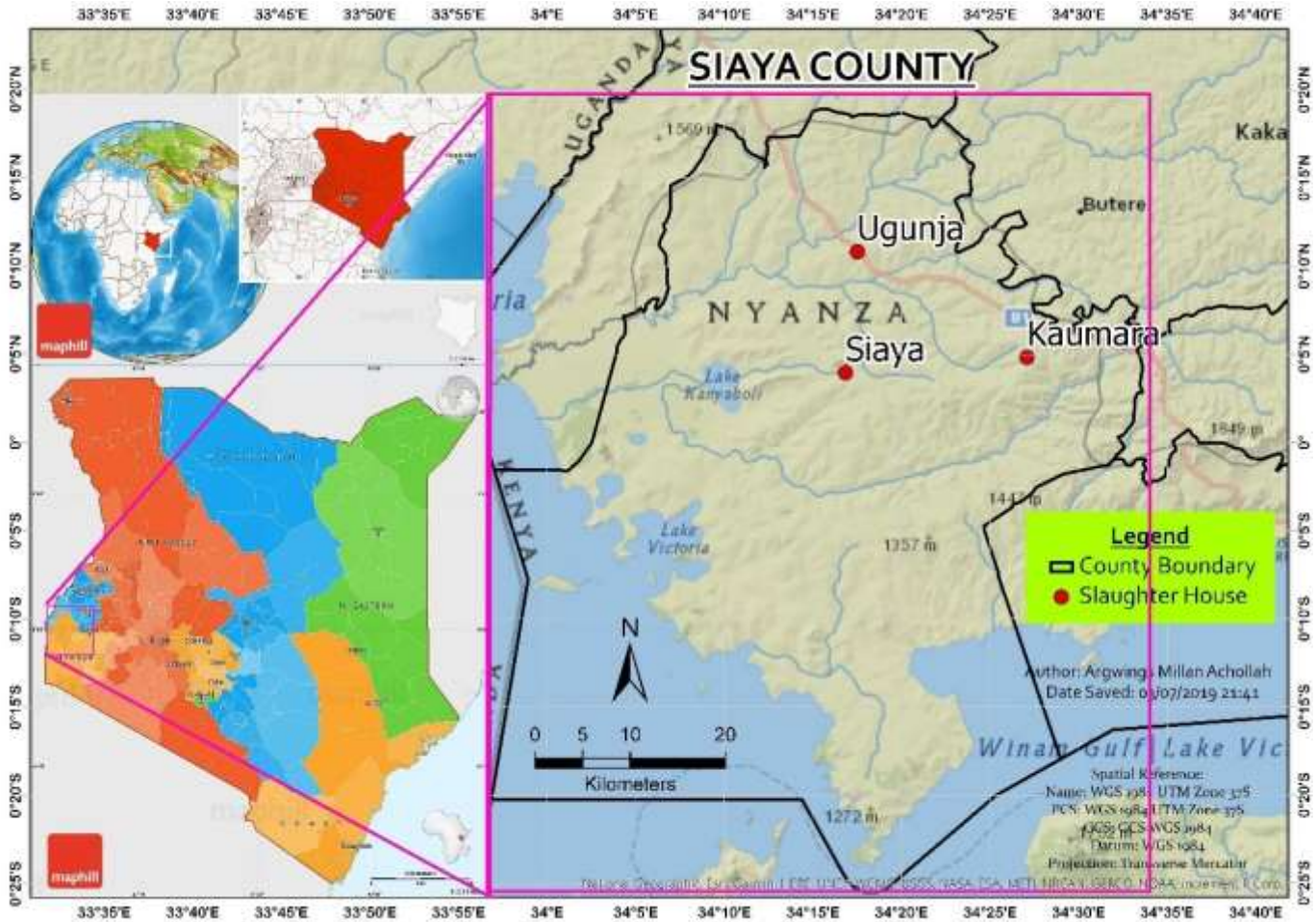

Figure 1. The location of the study area and Global Positioning System (GPS) points for slaughterhouses (Ugunja, Siaya, and Kaumara) visited. Generated from maphill.com, Google Earth Pro and ARC GIS version 10.5 software.

activities. In 2016, among the marketed agricultural products, cattle and milk were valued at Kenya Shillings (KShs) 84.7 and 23 billion, respectively (KNBS, 2017). However, the potential of cattle production has not been fully maximized, owing to diseases conditions (Tembo and Nonga, 2015). A majority of these conditions are often detected during meat inspection, causing partial or total condemnation of affected organs (Ninios et al., 2014). In consequence, wastage of consumable organs and losses of income for livestock farmers and traders occurs. Some of the conditions are zoonotic and may result in human epidemics (Cook et al., 2017). Proper diagnosis of these conditions needs to be made to know the particular management route to undertake (OIE, 2018). This can be done through observation of clinical manifestations on live animals and gross examination at post mortem (OIE, 2018). This may give a rough indication of the suspected disease, but it is usually not confirmatory (Stockham and Scott, 2013). Laboratory techniques such as bacteriology, parasitology and histopathology are needed to define the disease condition (OIE, 2018). Slaughterhouses thus play a key role in animal disease surveillance and epidemiology (Tembo and Nonga, 2015). There are only scanty reports on the disease conditions and organ condemnations in Siaya County and no previous published studies. This study, therefore, concentrated on establishing the definitive cause (s) for organ condemnations in three slaughterhouses, namely: Kaumara, Siaya and Ugunja in Siaya County, Kenya, through pathological, bacteriological and parasitological laboratory techniques and quantifying the wasted edible organs and the respective financial losses incurred by the farmer.

MATERIALS AND METHODS

Study area

Siaya County (Figure 1) is located in the Western region of Kenya, between latitude 0° 26´ South and 0° 18' North and longitude 33° 58' East to 34° 33' East. The average rainfall ranges between 800 and 2,000 mm per annum with mean temperatures of 16 to 29°C annually, favouring both crop and livestock production (KNBS, 2015).

Study design

A cross-sectional study was conducted between 5th June and 4th July 2018 in three slaughterhouses (Kaumara, Siaya, and Ugunja). Slaughtered carcasses and eviscerated organs were examined for gross lesions and condemned materials were sampled for laboratory analyses and their monetary values estimated using the prevailing market prices per kilogram.

Slaughterhouse selection and mapping

The slaughterhouses were conveniently selected based on their high cattle throughput, proximity to town centres and shorter distance between them. They were georeferenced and presented using Garmin GPSMAP64S device, maphill.com Google Earth Pro and ARC GIS version 10.5 software.

Sampling method and sample size determination

Study animals (cattle), were selected by convenience sampling, assigned a unique identification number and their breeds, sex, and origin recorded in printed data sheets. Sample size determination was guided by the formula below (Yamane, 1973), at a 90% confidence level and *p*=0.1.

$$n = \frac{N}{1 + N(e^2)}$$

Where *n* = the required sample size, *N* = cattle population size (346,071) in Siaya County (GoK, 2013), and e = level of precision (0.1). Thus, n=346,071 / [1+346,071(0.1)^2] = 99.97 ≈ 100. The sample size was divided at a ratio of 3:2:2 for Kaumara, Siaya and Ugunja slaughterhouses, respectively, and study animals consecutively selected in order of arrival, one slaughterhouse at a time, until a convenient sample size of 112 animals was reached.

Post-mortem inspection

Post-mortem (PM) inspection was carried out using established procedures (GoK, 2012).

Sample collection for laboratory analyses

Sterile cotton swabs in Amie's transport media were used to aseptically collect a specimen for bacterial isolation and identification (Tille, 2017), while impression smears were prepared from enlarged organs for cytology (OIE, 2013). Visible worms were collected and preserved in 70% ethanol for taxonomic identification (Pires et al., 2012). Portions of condemned organs were also fixed in 10% neutral buffered formalin for histopathology (Suvarna et al., 2013). Intestinal nodules were dissected out and randomly assigned for either histopathology or digestion in pepsin-hydrochloric acid (HCL), to demonstrate nematode larvae. All laboratory investigations were carried out at the Department of Veterinary Pathology, Microbiology and Parasitology, University of Nairobi.

Laboratory analysis

Bacterial isolation and identification

Swabs were streaked separately into both Blood Agar and MacConkey Agar plates and incubated aerobically at 37°C overnight or up to 48 h. Bacterial isolates were identified based on colony morphology, Gram staining and biochemical tests (Tille, 2017).

Identification of hemoparasites and cytology

Impression smears were stained with Giemsa and examined using a light microscope for the presence of hemoparasites and cellular morphology (OIE, 2013).

Identification of worms

Worms recovered from infested livers were stained with Aceto carmine (International Institute of Parasitology, 1994) and examined using a stereomicroscope for morphological features and species identification (Taylor et al., 2016). Their morphometric parameters were measured using a calibrated light microscope (Halakou et al., 2017). Intestinal nodules were processed for histopathology and examined using a light microscope for the presence of the nematode larvae and tissue reaction (Suvarna et al., 2013). Intestinal nodules digested in pepsin-HCL, were washed in clean water, diluted and every drop examined in a Petri dish using a light microscope (Ministry of Agriculture, 1986). Nematode larvae recovered were examined for key morphological features including head and tail characteristics (Taylor et al., 2016).

Histopathological characterization

The formalin-fixed specimens were paraffin-embedded, sectioned at a 5 µm thickness and stained with Hematoxylin and Eosin (H & E) (Suvarna et al., 2013). Special stains, Prussian blue method for hemosiderin and Fontana Masson method for melanin (Dey, 2018), were used to characterize abnormal pigments in spleen and liver tissues, respectively. Histopathology was conducted to identify and characterize tissue alterations and/or causes.

Estimation of direct financial losses associated with organ condemnation

The direct financial losses (*DFL*) were computed using the equation described by Mwabonimana et al. (2010).

$$DFL = \sum (NC \times WT \times RP)$$

where *DFL* = direct financial losses, *NC* = number of the condemned organ (livers/lungs/kidneys/intestines/hearts/muscle, etc.), *WT* = weight (kg) of the condemned organ, *RP*=prevailing retail prices of the respective condemned organ.

Data analysis

Collected data were entered into Microsoft Excel 2016, computed and exported to IBM-SPSS statistics version 21 for statistical analysis. Descriptive statistics were used to summarize the data. Proportions of organ condemnations (*PCs*) were calculated using the following equation (Jaja et al., 2018):

$$PCs = \frac{number\ of\ organs\ condemned}{Total\ number\ of\ cattle\ slaughtered}$$

Differences in means of organ condemnations between the three

Table 1. Phenotypic characteristics and county of origin of slaughtered cattle and (%) representation.

Characteristics		Slaughterhouse			
		Kaumara (%)	Siaya (%)	Ugunja (%)	Total (%)
Sex	Male	21 (45.6)	25 (73.5)	24 (75)	70(62.5)
	Female	25 (54.3)	9 (26.5)	8 (25)	42 (37.5)
Breed	Zebu (%)	44 (95.7%)	32 (94.1)	32 (100)	108 (96.4)
	Exotic (%)	1 (2.2)	0	0	1 (0.9)
	Zebu/Exotic (%)	1 (2.2)	2 (5.9)	0	3 (2.7)
County of origin (%)	Siaya	38 (82.6)	11 (32.4)	18 (56.3)	67 (60)
	Busia	0	15 (44.1)	12 (37.5)	27 (24)
	Homabay	7 (15.2)	5 (14.7)	0	12 (10.7)
	Migori	1 (2.2)	3 (8.8)	0	4 (3.6)
	Kakamega	0	0	2 (6.3)	2 (1.8)
Total (n)		46 (41.1)	34 (30.4)	32 (28.6)	112

Table 2. Number of animals with/without conditions, organ condemnation type and % representation out of 112 carcasses.

Criterion		Slaughterhouse (%)						Total (%)
		Kaumara		Siaya		Ugunja		
Number of animals with ≥1 pathological condition (s) (%)		30 (65.2)		25 (73.5)		20 (62.5)		75 (67)
Number with 1 condition (%)		25 (83.3)		17 (68)		15 (75)		57 (76)
Number with >1 condition (%)		5 (16.7)		8 (32)		5 (25)		18 (24)
Number without condemnation (%)		16 (34.8)		9 (26.5)		12 (37.5)		37 (33)
Condemnation type		**WC[a]**	**PC[b]**	**WC[a]**	**PC[b]**	**WC[a]**	**PC[b]**	
Organ	Liver	17	7	9	13	5	8	59 (53)
	Gastrointestinal tract (GIT)	0	9	0	8	0	11	28 (25)
	Lungs	1	0	1	0	0	0	2 (1.8)
	Spleen	1	0	1	0	0	0	2 (1.8)
	Muscles	0	0	1	0	0	0	1 (0.9)

[a]Whole organ condemnations; [b]Partial organ condemnations.

slaughterhouses were analysed using ANOVA and Bonferroni *post hoc* test. A significant difference was considered at p≤0.05, at 95% confidence interval.

Research approval

Research proposal approval was obtained from the University of Nairobi while the County Director of Veterinary Services, Siaya County permitted visits to the three selected slaughterhouses. This work did not involve any studies on live animals.

RESULTS

Out of the 112 cattle slaughtered and inspected during the 1-month study period, 46 (41%) were at Kaumara, 34 (30.4%) at Siaya and 32 (28.6%) at Ugunja slaughterhouse (Table 1).

Number and type of organ condemnations

Out of the 112 cattle slaughtered, 75 (67%) of them had at least one condition causing partial or total condemnation of affected organs, while 37 (33%) had no organs condemned (Table 2).

Samples collected and laboratory analyses performed

In total, 194 samples were collected for laboratory analyses (Table 3).

Conditions causing organ condemnation

Hepatic fasciolosis was diagnosed in 58 (51.8%) cattle livers, constituting 98.3% of all livers condemned.

Table 3. Number of samples collected and respective laboratory analyses performed.

Organ	Slaughterhouse			Total no. of samples collected	Laboratory analyses performed		
	[a]SK	[b]SS	[c]SU		Parasitological	Histopathology	Bacteriological
Liver	55	70	30	155	87	67	1
GIT	5	19	4	28	8	20	0
Spleen	3	3	0	6	2	2	2
Lungs	2	2	0	4	0	2	2
Muscles	0	1	0	1	0	0	1
Total	65 (33.5)	95 (49)	34 (17.5)	194	97 (50%)	91 (46.9%)	6 (3.1%)

[a]Kaumara, [b]Siaya and [c]Ugunja slaughterhouses.

Twenty-four (52.2%) were obtained from Kaumara, 21 (61.8%) from Siaya and 13 (40.6%) from Ugunja Slaughterhouses. All the 58 infected livers exhibited engorged bile ducts, typical of pipe-stem liver disease and numerous adult liver flukes when cut. Black circular focal areas of pigmentation were observed in 1 (1.7%) of them. Greyish, locally extensive indurated area, with an uneven surface covered by an off-white/pale pink, soft but tough tissue was observed in 1 (0.9%) infested liver. At histopathology, 55 (94.8%) of the liver samples showed loss of normal lobular architecture. The black-pigmented areas revealed fine yellowish-brown/black granules intermixed with hepatocytes. The greyish locally indurated area exhibited marked alteration of the normal lobular architecture, scattered foci of regenerative hepatocytes, separated by bands of fibrous connective tissue, indicating hepatic fibrosis. Eighty-seven liver flukes were collected from the infested livers; all of them had a mean body length of 30 mm and body width of 6 mm, leaf-shaped with a short conical anterior end and barely distinguishable shoulders, characteristic of *Fasciola gigantica*.

Hepatic hydatidosis was diagnosed in the liver of one cow (0.9%) at the Ugunja slaughterhouse. The liver had soft to firm multifocal areas of clear fluid-filled cysts measuring 1.5 to 3 cm in diameter, typical of hepatic hydatidosis. At histopathology, fibrous laminated cyst-walls compressed hepatic parenchyma leading to variable hepatocyte degeneration, congestion of hepatic sinusoids and central veins.

Intestinal nematodiasis (pimply gut) was diagnosed in 28 (25%) cattle; 5 (17.9%) were from Kaumara, 19 (67.9%) in Siaya and 4 (14.3%) in Ugunja slaughterhouse. On gross examination, 3 to 5 mm diameter nodules were observed on the serosal surfaces of both small and large intestines. At histopathology, 20 (71.4%) randomly selected nodules exhibited focal to multifocal irregular/round-shaped structures within the intestinal walls with mixed inflammatory infiltrates, centred on the nematode larvae and its remnants in 5 (25%) of them. Of the 8 (28.6%) nodules digested in pepsin-HCL, the nematode larvae were recovered from 2 (25%) of them, which exhibited broad, rounded heads, long cephalic space and filamentous tail sheath consistent with *Oesophagostomum* species.

Pulmonary blood aspiration was diagnosed in 2 (1.8%) slaughtered cattle, from Kaumara and Siaya slaughterhouses. Both lungs had dark-red multiple/coalescing foci with feathery boundaries under the visceral pleura. Cutting through such areas, clotted blood and small scattered pieces of ingesta were observed in the trachea, bronchi, and bronchioles. At histopathology, abundant erythrocytes within alveolar sacs and bronchioles were conspicuous. Bacterial isolation and identification results from this sample were consistent with *Escherichia coli* and α-hemolytic *Streptococcus* isolates. The other lung sample revealed only blood in the trachea, bronchi, and bronchioles. At histopathology, abundant erythrocytes within alveolar sacs, bronchi and bronchioles were observed. Bacterial isolation and identification results from this sample were consistent with *Corynebacterium* and coagulase-negative *Staphylococcus* isolates.

Muscle abscess was diagnosed in one animal (0.9%) at the Siaya slaughterhouse. A non-mobile swelling, measuring 15 cm in diameter on the left masseter muscle was observed, containing abundant yellowish brown/red fluid, nearly 1.0 L, admixed with necrotic tissue debris. Bacterial isolation and identification results from the abscess swabs were consistent with *Corynebacterium pseudotuberculosis* and *Streptococcus agalactiae* isolates.

Splenomegaly was diagnosed in 2 cattle (1.8%), at Kaumara and Siaya slaughterhouses. On gross examination, the spleen at Kaumara was dark red, soft, diffusely enlarged and bulging when cut. At histopathology, it had a disorganized architecture with marked deposition of brownish granular pigment in the red pulp. On staining with Prussian blue method, the pigment deposits stained intensely blue, thus confirming splenic hemosiderosis. Microscopic examination of impression smear from the spleen sample also revealed multifocal areas of grey/brown granular material of varying sizes, irregular-shaped/fragmented erythrocytes and a few scattered polymorphonuclear cells. Bacterial isolation and identification results from this sample were consistent with β-hemolytic *Streptococcus* isolates. On gross examination, the spleen at Siaya slaughterhouse

Table 4. Conditions leading to organ condemnation, category, number condemned and their percentage representation out of the 112 slaughtered cattle.

Organ	Condition	Category	Number condemned	%
Liver	Fasciolosis	Parasitic	58	51.8
	Hydatidosis	Parasitic	1	0.9
Intestines	Intestinal nematodiasis (Pimply gut)	Parasitic	28	25
Lung	Blood aspiration	Poor slaughtering technique	2	1.8
Spleen	Splenomegaly	Disturbance in cell metabolism (Hemosiderosis)	1	0.9
	Splenomegaly	Circulatory disturbance (Congestion)	1	0.9
Muscle	Abscess	Inflammatory processes	1	0.9

Table 5. Organs condemned, respective weights, prevailing prices and the computed financial losses (KShs and US$) in the three slaughterhouses in Siaya County, Kenya.

Organ	Slaughterhouse, weights of condemned organs and the respective prevailing prices/kg									
	Kaumara			Siaya			Ugunja			
	WT	KShs/kg	Total	WT	KShs/kg	Total	WT	KShs/kg	Total	TOTAL
Liver	79	500	39,600	59.5	500	29,750	36	500	18,000	87,350
GIT	0.9	260	229	0.83	260	215	9.4	260	2,436	2,880
Spleen	2.1	500	1,050	1.5	500	750	0	500	0	1,800
Lungs	4	260	1,040	4	260	1,040	0	260	0	2,080
Muscle	0	360	0	1	360	360	0	360	0	360
Total weight	86	-	-	66.8	-	-	45.4	-	-	198.2
Total (KShs)		41,919			32,115			20,436		94,470
Mean (KShs)										31,490
Total US$ (KShs 101)		415			318			202		935

was dark red and diffusely enlarged as well, rather firm, bulging and oozing little blood when cut. At histopathology, the red pulp was expanded and its vascular spaces distended with erythrocytes, characteristic of splenic congestion, while the white pulp was scattered and had barely noticeable lymphoid follicles. Many neutrophils were observed in the red and white pulp. On microscopic examination of impression smear, an increased presence of neutrophils, macrophages, and erythrocytes was observed. Bacterial isolation and identification results from this sample were consistent with *Corynebacterium pilosum* and another *Corynebacterium* species isolates.

The conditions accounting for condemnation of organs in cattle at the three slaughterhouses are summarized in Table 4. No statistically significant difference (p=0.99) was observed in condemnation of organs in all the three slaughterhouses.

Financial losses associated with organ condemnation during the study

The total weight of edible organs condemned during the study was 198.2 kg, which translated to Kenya Shillings (KShs). 94,470 (US$. 935) loss (mean: KShs. 31,490) (Table 5).

DISCUSSION

This study has revealed that over 50% of the population of cattle slaughtered at the three slaughterhouses had one or more organs condemned due to various conditions, consequently, loss of edible organs and heavy financial losses were incurred. Parasitic conditions namely, hepatic fasciolosis and pimply gut, caused the highest proportion of condemnations. In a similar study in Dodoma Tanzania, the highest condemnation rates were also caused by fasciolosis and pimply gut (Tembo and Nonga, 2015).

The high proportion of parasitic conditions could be attributed to the ubiquitous nature of helminth parasites of cattle and other species and the conducive environmental conditions in the tropics and subtropics, favouring their survival and spread (Taylor et al., 2016; Wadhwa et al., 2011).

In hepatic fasciolosis, lesions typical of pipe-stem liver

disease were evident and were comparable to those encountered at Sulaimani abattoir in Iraq (Salmo et al., 2014). These lesions develop from repeated fluke infestations, progressive hepatitis, and fibrosis in portal units, as a result of the direct irritation by flukes, biliary stasis and concomitant infections (Cullen and Stalker, 2016). At the histopathological examination, the black-pigmented area of one infested liver revealed yellowish-brown/black fine granules, consistent with "fluke puke"/iron-porphyrin pigment (Cullen and Stalker, 2016). Histochemical staining of the pigment was negative for both iron and melanin. All the liver flukes were identified morphologically as *F. gigantica*. The morphometric characteristics measured for the *F. gigantica*, were consistent with the standardized ones (Valero et al., 2006), and were comparable to those of Halakou et al. (2017) in Iran, in which body length of 26.8 to 32.1 mm with a mean of 29.5 and body width of 5.9 to 8.1 mm with a mean of 7 were recorded. The parasite causes outbreaks mainly in tropical areas of Africa and Asia (Taylor et al., 2016), causing low production in adults and poor weight gain in young animals (Salmo et al., 2014). The high proportion of *F. gigantica* infestation in this study differed from those of Asfaw (2018) in Ethiopia, who morphologically identified 69 (59.9%) as *Fasciola hepatica*, 13 (11%) *F. gigantica* and 33 (29%) as mixed species and immature ones. The high proportion of hepatic fasciolosis encountered suggests a possible zoonotic risk, as drinking contaminated water or consuming metacercaria in vegetables predisposes to human infection (Nyindo and Lukambagire, 2015). Visible fluid-filled cysts of varying sizes were observed bulging from the surface of a condemned liver. At histopathology, these were confirmed as hydatid cysts (Cullen and Stalker, 2016). The gross and microscopic findings recorded agreed with the findings of Singh et al. (2016). Congestion of hepatic sinusoids, central veins and hepatocyte degeneration observed, was caused by pressure from the developing fluid-filled cysts (Singh et al., 2016). The occurrence of cystic echinococcosis in humans is closely related to that of domestic herbivores (Mandal and Mandal, 2012), thus its occurrence in this study suggests a possible zoonotic transmission. Most of the pimply gut nodules observed in this study did not contain the nematode larvae. This agrees with the study of Chamuah et al. (2016), who also reported that 66.7% of the nodules lacked them. Absence of the larvae may have occurred either from the death and fragmentation of the parasites as a result of immunological reactions or their exit out of the nodules back into the gut lumen in the progression of their development (Taylor et al., 2016; Nwosu et al., 2012). Hepatic fibrosis in this study was attributed to fasciolosis, where migration of immature liver flukes plus bile duct obstruction, may lead to chronic inflammation and fibrosis, consistent with the findings of Rashid et al. (2018). Pulmonary blood aspiration is reported to be frequently encountered at slaughter (Cullen and Stalker, 2016). Histopathological findings observed in the condemned lungs in this study agreed with the findings of El-Siddige (2003). Bacterial isolation results were consistent with *E. coli* and *Streptococcus* isolates from one lung sample and *Corynebacterium* isolates from the second sample. However, the absence of inflammatory changes was not characteristic of infection by the bacteria isolated; the occurrence of these organisms in the lung tissue could have accompanied the aspirated materials. Besides, previous studies have isolated similar bacteria from the upper respiratory tract of normal camels at slaughter in Athi River, Kenya (Mutua et al., 2017). Pulmonary blood aspiration observed in this study can be attributed to lack of stunning during the slaughter process; in which the loss of consciousness is prolonged, leading to aspiration of blood (Gregory et al., 2009). *C. pseudotuberculosis* nitrate-reducing biotype, causes ulcerative lymphangitis and abscesses in cattle and horses, while streptococci group of bacteria are not only frequently commensals on mucous membranes with many infections considered opportunistic, but also cause pyogenic infections, suppurative lesions, chronic mastitis (*S. agalactiae)* and septicaemia in various animal species (Quinn et al., 2016). For the present study therefore, *S. agalactiae* isolated were considered contaminants during the slaughter process while *C. pseudotuberculosis* was taken as the main cause of the muscle abscess since it causes the condition in cattle as stated above. Enlargement and discoloration led to condemnation of two spleens. Special histochemical staining done on the first spleen confirmed splenic hemosiderosis, while bacterial isolation and identification results were consistent with β-haemolytic *Streptococcus* isolates. The splenic enlargement resulted from a massive accumulation of hemosiderin by other causes not established by this study, different from the β-haemolytic *Streptococcus* isolated, since these organisms are usually found in cases of septicaemia, abscesses and many other suppurative conditions (Quinn et al., 2016). For the second spleen sample, microscopic lesions were mainly: congested vascular spaces in the red pulp and scanty white pulp, while impression smears showed increased presence of neutrophils, macrophages, and erythrocytes. Bacterial isolation and identification results were consistent with *Corynebacterium pilosum* and other *Corynebacterium* isolates. In cattle, *Corynebacterium* organisms cause a wide range of diseases including subclinical mastitis (*C bovis*), mastitis (*C ulcerans*), cystitis and pyelonephritis (*C renale* type I and *C pilosum*), abscesses and ulcerative lymphangitis (*C. pseudotuberculosis* nitrate-reducing biotype) (Quinn et al., 2016). Therefore, the lesions suggested splenic congestion, and could have been caused by other agents, different from the isolated bacteria.

The loss of 198.2 kg of edible organs indicates a heavy loss of a key source of protein for consumers and income

for farmers and livestock traders. The scale of financial losses incurred was lower than what was obtained in similar research conducted in Tanzania (Tembo and Nonga, 2015). The disparity may be attributed to differences in the number of animals slaughtered, hence the number of organs condemned. Nonetheless, it is important to note that the actual frequency of the disease conditions in slaughtered animals was perhaps underestimated owing to the few slaughterhouses and animals sampled. A limitation of this study was the convenient sampling method employed. The data collected from the three slaughterhouses cannot be inferred to the remaining 29 slaughter facilities. Despite that, the results offer novel and valuable information for any upcoming disease control program, future research and the magnitude of economic losses due to organ condemnation in Siaya County.

Conclusion

A large number of organs were condemned at slaughter due to controllable parasitic, bacterial and conditions associated with poor slaughtering techniques. The occurrence of hepatic fasciolosis and hydatidosis suggested a risk of zoonotic transmission. The financial losses as a result of organ condemnations were also considered high and indicative of high economic losses for livestock farmers and traders. The study recommends enhanced sensitization of farmers towards controlling the conditions at farm level and sensitization of slaughterhouse workers towards proper slaughter techniques, so as to reduce losses of edible organs at slaughter. Further research needs to be undertaken on fasciolosis and hydatidosis, employing more advanced laboratory methods such as molecular techniques to determine a possible zoonotic transmission

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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