



Pathological findings of condemned bovine liver specimens and associated economic loss at Nyabugogo abattoir, Kigali, Rwanda

Gervais Habarugira^{a,*}, Gloria Mbasinga^a, Borden Mushonga^b, Chitura Teedzai^c, Erick Kandiwa^b, Lonzy Ojok^a

^a School of Animal Sciences and Veterinary Medicine, College of Agriculture, Animal Sciences and Veterinary Medicine, University of Rwanda, Rwanda

^b School of Veterinary Medicine, Faculty of Agriculture and Natural Resources, University of Namibia, Namibia

^c Department of Agricultural Economics and Animal Production, University of Limpopo, South Africa

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ABSTRACT

There are no published abattoir bovine hepatic lesion prevalence studies in cattle in Rwanda. This study estimated that 12.3% of the livers (n = 4751) examined at Nyabugogo slaughterhouse in Kigali were condemned. Condemnation prejudiced the nation of 3492.00 kg of meat with attendant economic losses of US\$8932.40 during the study period. Risk factors for these lesions were also assessed. Male and female animals from 11 districts were used in this study. Hepatic lesions were higher in females (14.6%; n = 1494) than in males (11.1%; n = 3257). About 78.7% of the condemnations were due to fascioliasis, followed by abscesses (5.7%), hepatitis (5.3%), cirrhosis (4%) and other lesions (6.3%). Female animal livers showed more fascioliasis and abscesses (82.2% and 9.5%) than male animal livers (73.3% and 3.3%). The highest rate of condemnation was observed from Kayanza (40.2%; n = 413) and the least was from Gakenke district (0.9%; n = 1031). Cattle from the Eastern Province showed significantly ($P < 0.05$) higher prevalence of condemnations (26.8%) than the rest of the provinces. Liver specimens of animals below 3 years and above 6 years of age had a significantly higher ($P < 0.05$) condemnation rate (14.4%) (n = 3000 and n = 769) than the 3–6 year age-group at 4.1% (n = 982). We conclude that fascioliasis was responsible for a significant proportion of the liver condemnations at Nyabugogo slaughterhouse. Being a zoonosis, we recommend an epidemio-surveillance, implementation of control measures and anthelmintic resistance investigation for fascioliasis in Rwanda.

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1. Introduction

The liver is one of the most important organs in the animal's body. It is the principal organ of metabolism for many endogenous and exogenous substances and as a result, is one of the frequently affected organs in a diseased body (Alawa et al., 2011; Sohair and Eman, 2009).

The liver is susceptible to a wide range of metabolic, toxic, microbial and circulatory insults (Bal et al., 2004). The main causes of liver condemnation during post-mortem inspection are diseases caused by parasites mainly *Fasciola spp.*, bacteria and viruses (Mohammed et al., 2012; Radostits et al., 1994; Mas-Coma et al., 2005).

Due to its large regenerative capacity, the liver from clinically healthy animals in tropical and subtropical countries tends to show

a spectrum of disease and pathological conditions at slaughter (Abunna et al., 2010; Mohammed et al., 2012; Raji et al., 2010; Alawa et al., 2011).

Fascioliasis is one of the major diseases responsible for direct and indirect economic losses in livestock production, particularly cattle (Abutarbush, 2010; McDowell and Rafati, 2014; Dietrich et al., 2015). High prevalence is reported in areas surrounding inland water bodies such as dams or large ponds in which snails, particularly *Lymnaea* species are found (Sissay et al., 2007).

Bovine liver telangiectasis, a focal dilation and congestion of a group of hepatic sinusoids, is the most common liver lesion in cattle in different countries world-wide. The condition is mainly associated with a number of liver diseases including liver flukes (Doustar et al., 2011).

The prevalence of liver lesions is unknown in Rwanda as there is no published reports on this subject. Therefore, an important objective for this study is to reveal the nature and estimated frequency of hepatic lesions in slaughtered cattle at Nyabugogo abattoir in

* Corresponding author.

E-mail address: gervais@unrw.ac.rw (G. Habarugira).

Kigali. In addition, risk factors and economic losses associated with the occurrence of these lesions will be assessed.

2. Materials and methods

2.1. Geographical study area

The study was carried out at SABAN-Nyabugogo abattoir located in the commercial zone of the north-western part of Kigali. The abattoir is divided into two parts; one for bovine and the other for small ruminant processing.

2.2. Experimental animals

The slaughtered cattle were brought from the Northern Province (Rulindo, Gakenke, Gicumbi), Eastern Province (Nyagatare, Kayonza, Gatsibo, Bugesera, Kirehe), Southern Province (Ruhango, Kamonyi) and the Western Province (Ngororero).

2.3. Study design

A cross-sectional study was carried out at SABAN Nyabugogo abattoir. The study was conducted from March to May 2013. The sampling involved all bovines brought to the abattoir during the period of study.

2.4. Meat inspection

Routine meat inspection was carried out by meat inspectors under the supervision of registered veterinarians. The study involved 4751 cattle slaughtered at SABAN-Nyabugogo abattoir in Kigali. All inspected carcasses were tagged and the same identification number was given to the corresponding offal.

2.5. Macroscopic examination of the liver and economic loss estimate

All the livers were examined for abnormalities in colour, smell, size, sharpness of edges, smoothness of surfaces and organ consistency in a systematic manner. All bile ducts were incised transversely as well as longitudinally to check for the presence of parasites or other lesions. Hepatic lymph-nodes were examined and incised. A digital camera was used to record macroscopic hepatic lesions.

The economic estimate was estimated by multiplying the total weight of the condemned meat by the prevailing price per kg of liver at the time of the study. The total weight of condemned liver was obtained by multiplying the number of condemned liver specimen by the average weight of a normal liver (6 kg).

2.6. Data analysis

Demographic and epidemiological data were analysed using descriptive statistics. Categorical variables were described using percentages. Bi-variate analysis for cause of liver condemnation (risk factors) was performed using Pearson's χ^2 test. P -values ≤ 0.05 were considered significant. All the collected data was entered and managed in MS Excel and later SPSS version 16.1.

2.7. Ethical considerations

Ethical approval for this study was obtained from the research committee of the School of Animal Sciences and Veterinary Medicine, College of Agriculture, University of Rwanda. Meat inspection was performed under the supervision of a qualified and registered veterinarian who carried out routine ante-mortem

Table 1
Prevalence of liver condemnations according to district.

District	Number of animals slaughtered	Number of livers condemned at slaughter	Rate of liver condemnation within district (%)
Eastern Province			
Kayonza	413	166	40.2
Nyagatare	673	203	30.2
Gatsibo	341	82	24.0
Bugesera	192	18	9.4
Kirehe	181	14	7.7
Northern Province			
Gicumbi	129	9	7.0
Rulindo	1180	36	3.1
Gakenke	1031	9	0.9
Southern Province			
Kamonyi	176	11	6.3
Ruhango	215	10	4.7
Western Province			
Ngororero	220	24	10.9
Total	4751	582	–

Table 2
Occurrence of liver condemnations according to province.

Province	Number of animals slaughtered	Number of livers condemned at slaughter	Rate of liver condemnation within province (%)
Eastern Province	1800	483	26.8
Northern Province	2340	54	2.3
Southern Province	391	21	5.4
Western Province	220	24	10.9
Total	4751	582	–

Table 3
Occurrence of liver condemnations according to sex of slaughtered animal.

Sex	Number of slaughtered animals	Number of condemned livers at slaughter	Percentage condemned (%)
Males	3257	363	11.1
Females	1494	219	14.6
Total	4751	582	12.3

and post-mortem inspection. In addition, written consent was also obtained from slaughterhouse owners prior to the commencement of the study.

3. Results

3.1. Overall prevalence of hepatic lesions in livers condemned at slaughter

As shown in Table 1, 582 livers representing 12.3% of all the livers ($n = 4751$) inspected were condemned in slaughtered animals from all the districts. The highest rate of condemnations was found in animals from Kayonza (40.2%; $n = 413$); Nyagatare (30.2%; $n = 673$); and Gatsibo (24.0%; $n = 341$). The lowest rate of liver condemnations was found in animals from Gakenke (0.9%; $n = 1031$). At the provincial level liver condemnations were significantly higher ($P < 0.01$) in animals from the Eastern province (26.8%; $n = 1800$) compared to those from the Northern (2.3%; $n = 2340$), and Southern provinces (5.4%; $n = 391$). Condemnations from the Western province (10.9%; $n = 220$) were also significantly lower ($P < 0.05$) than those from the Eastern province (Table 2).

Table 3 shows that 11.1% of the livers from all the slaughtered males ($n = 3257$) were condemned and 14.6% of the livers from all the slaughtered females ($n = 1494$) were condemned. Statistical

Table 4
Occurrence of liver condemnations according to age of slaughtered animal.

Age (years)	Number of slaughtered animals	Number of condemned livers at slaughter	Liver condemnation within age group (%)	Prevalence of condemnations (%)
<3	3000	431	14.4	43.8
3–6	982	40	4.1	12.4
>6	769	111	14.4	43.8
Total	4751	582	100.0	100.0

Table 5
Overall occurrence of hepatic lesions responsible for liver condemnations.

Lesion	Number of animals	Occurrence (%)
Fascioliasis	458	78.7
Abscess	33	5.7
Cirrhosis	19	3.3
Hepatitis	31	5.3
Fatty liver	10	1.7
Suspected smell of drugs	10	1.7
Congestion	11	1.9
Jaundice	6	1.0
Total	582	100.0

Table 6
Occurrence of hepatic lesions according to sex of animal.

Lesion	Number of male animal livers	Percentage (%)	Number of female animal livers	Percentage (%)
Fascioliasis	266	73.3	180	82.2
Abscess	34	9.4	7	3.2
Hepatitis	16	4.3	12	5.5
Cirrhosis	13	3.6	10	4.5
Fatty liver	13	3.6	1	0.5
Jaundice	10	2.8	3	1.3
Congestion	4	1.1	4	1.8
Suspected smell of drugs	7	1.9	2	1.0
Total	363	100.0	219	100.0

analysis, however, failed to show any significance in the difference in liver condemnations between the male and female animals slaughtered ($P > 0.05$).

As shown in Table 4, the prevalence of liver condemnations in animals below three years of age (43.8%) and above six years of age (43.8%) were significantly higher ($P < 0.05$) than those for the 3–6 year age-group (12.4%).

Most of livers were condemned due to evidence of fascioliasis (78.7%) (Fig. 1), followed by liver abscesses (5.7%) (Fig. 2), hepatitis (5.3%) (Fig. 4), liver cirrhosis (3.3%), congestion (1.9%), fatty liver (1.7%) (Fig. 3), smell of drugs (1.7%) and jaundice (1.0%). Condemnation from fascioliasis was significantly higher than liver condemnations from other causes at Nyabugogo abattoir ($p < 0.01$) (Table 5).

Table 6 shows the results of hepatic lesions responsible for condemnations according to the sex of slaughtered animals. Though fascioliasis was reported more in female livers (82.2%; $n = 219$) than in male livers (73.3%; $n = 363$), there was no statistical significance in these differences ($P > 0.05$). More abscesses were found in male livers (9.4%) than in female livers (3.2%). These differences, however, were also not statistically significant ($P > 0.05$).

3.2. Estimation of economic losses as a result of liver condemnation

A total estimate of 3492.00 kg of liver meat was condemned. At the current prevailing price of RWF 2000 per kg of liver, the loss

that resulted from liver lesions was estimated to be RWF6,984,000 (\$8932.40).

4. Discussion

In this study, the common pathological hepatic lesion at post-mortem inspection was fascioliasis which accounted for 78.7% of the total bovine liver condemnations. Our findings are consistent with those by Keyyu et al. (2003) in Tanzania's Iringa region where 100% of the livers were reportedly condemned due to liver flukes. Notably, Iringa region experiences similar eco-climatic conditions as some parts of Rwanda. On the other hand, observed occurrence of fascioliasis was higher than the 14.04% reported in Kilimanjaro region of Tanzania; and 12.7% reported in Ethiopia (Abunna et al., 2010; Swai and Ulicky, 2009).

Our studies revealed that districts within the lowlands of Rwanda's Eastern Province (Kayanza, Nyagatare and Gatsibo) had a higher prevalence of liver condemnations than the rest of the sampled districts (mostly from hills and highlands) (Ngendo, 2013). This high prevalence is possibly due to Rwanda's high annual rainfall (around 950 mm) distributed in two rainy seasons lasting up to 9 months (Muhire et al., 2015). Such wet conditions coupled with the higher temperatures (12–27 °C); swamps and wetlands provide conducive ecosystem for the developmental stages of *Fasciola hepatica* and *F. Gigantica* and their snail vector *Lymnaea* spp. These conclusions are in agreement with those of Kuchai et al. (2011) who reported higher prevalence of fascioliasis in the lowlands (37.14%) compared to 30.9% in the highlands of Ladakh, in Egypt.

Cattle from the highland districts, however, still showed presence of fascioliasis possibly due to the fact that the study was done during one of the two rainy seasons experienced in Rwanda. This finding further confirms the endemicity of fascioliasis in Rwanda regardless of geographical region.

Liver condemnations in slaughtered cattle in the 3–6 year age-group (12.4%) were fewer than those reported by Bhutto et al. (2012) in the 4–6 year age-group. However, the liver condemnations from the age groups in our study followed the same trend whereby younger (<3 years old) and older (>6 years old) animals showed the highest prevalence of fascioliasis. This trend was also reported in studies by Radfar et al. (2013), Amuamuta et al. (2012), Abdulhakim and Addis (2012). Radfar et al. (2013) reported a higher prevalence of liver condemnations in cattle less than 2 years of age (30.23%) compared to the 18.71% incidence in the 3–6 year age-group. Animals over 6 years showed 23.91% prevalence of liver condemnations. The waning of humoral immunity acquired at birth in cattle in the group below 3 years of age possibly explained this group's increased susceptibility to infections and hence the high prevalence of fascioliasis. The high prevalence of liver condemnations in cattle over 6 years of age was possibly due to prolonged exposure to causative agents and also partly due to their grazing in proximity to the wetland habitat of the intermediate host *Lymnaea luteola*, thereby increasing the risk of infection with *Fasciola* spp.

Our findings of high rates of fascioliasis in female than male cattle are similar to those by Affroze et al. (2013), in the districts of Bangladesh where more females (42.36%) were infected with fascioliasis than males (13.85%). Similarly, Kuchai et al. (2011), also reported higher prevalence of fascioliasis in females (38.07%) than males (30.09%) in the Ladakh district. The higher rates of fascioliasis reported in our study only proved that some districts in Rwanda pose a higher risk of cattle contracting fascioliasis than those from studies by other researchers (Chowdhury et al., 1994; Molina et al., 2005; Bhutto et al., 2012). These patterns were possibly due to the fact that female animals are prone to periods of pregnancy-related stress that sometimes lead to immunosuppression that eventually result in higher levels of *Fasciola* infections.

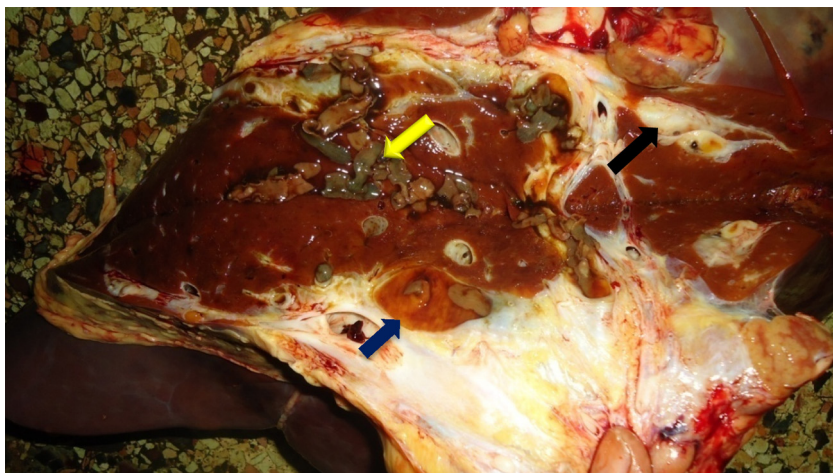


Fig. 1. Cut surface of the liver showing liver flukes (yellow arrow), thickening of bile ducts (black arrow) and mild jaundice (blue arrow). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

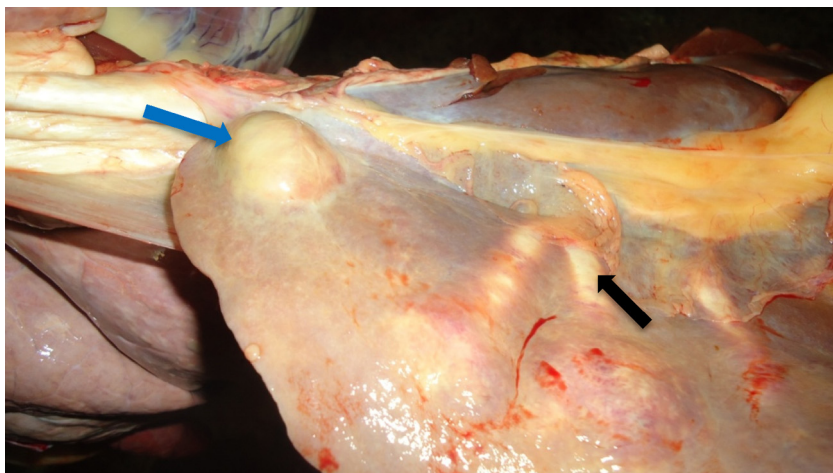


Fig. 2. Liver abscess (blue arrows) and prominent bile duct piping (black arrow). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)



Fig. 3. Condemned friable liver with fatty change.

The rate of occurrence of liver abscesses in this study (5.7%) is almost similar to 7.5% found by [Degheidy and Al-Malki \(2012\)](#) in Saudi Arabia despite the differences in eco-climatic conditions with Rwanda. The prevalence of liver abscess in this study was however,

higher than the 2.9% and 3.8% reported in Bangladesh ([Ahmedullah et al., 2007](#); [Cadmus and Adesokan, 2009](#)). Conversely, this prevalence is lower than the 10% reported by [Espinoza et al. \(2010\)](#) in Peru. Liver abscess along with the other lesions such as cirrhosis,



Fig. 4. Liver with bile duct fibrosis (arrow).

jaundice and hepatitis found in our study, is usually associated with bacterial diseases which move in as secondary infections in hepatic tissues damaged by migrating larvae of *Fasciola* spp. (Rosa et al., 1989).

Of the 11 districts studied in Rwanda, Rulindo, Nyagatare, Gakenke and Ngororero had the highest cases of liver condemnation of 17.2%; 16.1%; 12.2% and 11.4% respectively. Increased prevalence of liver infection could be attributed to sources of animal drinking water (dams and swamps) as well as certain sources of fodder. These wetlands pose the most risk since they are conducive to the lifecycle of *Fasciola* spp.; which apart from causing disease on its own also causes different secondary hepatic lesions. This is supported by other reports (Abdulahakim and Addis, 2012; Usip et al., 2014; Jean-Richard et al., 2014). In addition, poor farming systems can also be a source of liver infection (Jean-Richard et al., 2014; Affroze et al., 2013). In Rwanda, these two factors mostly contribute to the occurrence of liver diseases particularly fascioliasis.

Our reported overall incidence rate of 12.3% liver condemnations was considered a significant threat to the success of cattle production in sampled districts.

The fact that Rwanda has 9 months of annual rainfall and that local farmers extensively graze their animals, (relying on dams and swamps to water and feed their animals) explained the relatively high risk of exposure of animals to fascioliasis in this region. This poses a serious challenge for implementation of possible corrective and prophylactic measures needed to reduce and possibly eradicate liver diseases that lead to liver condemnations at the abattoir.

A number of liver specimens had suspected smell of drugs, showing that some farmers were not adhering to the stipulated withdrawal periods for veterinary drugs. The presence of these drugs in meat at slaughter posed serious threat to human health. Although it is not clear whether this apparent disregard of public health regulations was intentional or not, thorough investigation needs to be carried out (Lee et al., 2001; Ibrahim et al., 2010; Franco et al., 1990; Cully, 2014; Paige et al., 1997).

Considering the protein content of 26% for beef liver and an average animal protein requirement of 56 g per day per a sedentary average man, the condemned meat only over three months would be enough to feed 45 adult men for a year (365 days). However, this amount of condemned meat would feed more people since proteins are also obtained from food other than beef meat such as milk, fish, legume, cereals and nuts.

5. Conclusion

Meat inspection protocols successfully identified different lesions which led to liver condemnation in different categories of slaughtered cattle. Some of the factors associated with the prevalence of liver lesions were identified, and include age, sex and origin of the animals. We concluded that fascioliasis was the major cause of the liver condemnations encountered at Nyabugogo abattoir either as a primary disease or other lesions occurring secondary to fascioliasis. It has been also found out that liver condemnation is an important cause of significant economic loss and these condemned livers pose a threat to public health and food security. Considering the high prevalence of fascioliasis lesions at the abattoir, we recommend an investigation into possible anthelmintic resistance. Follow-up studies are needed in order to understand the true trend of livers conditions and the associated economic losses.

Competing interests

The authors declare that they have no financial or personal relationships which may have inappropriately influenced them in writing this article.

Authors' contributions

H.G. contributed to data collection and analysis, as well as write-up of the manuscript. M.G. contributed to data collection and in the writing of the manuscript. M.B. contributed to data analysis, manuscript writing and editing. C.T. contributed to data analysis and manuscript writing. E.K. contributed to data analysis, manuscript writing and editing. O.L. contributed to the project design and coordination, manuscript writing and editing.

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