# Prevalence and financial losses associated with *Bovine* fasciolosis at SAAFI and Sumbawanga municipal abattoirs, Rukwa, Tanzania

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## SUMMARY

This study was conducted to determine the prevalence and financial losses of *Bovine* fasciolosis at SAAFI and Sumbawanga municipal abattoirs. Primary data was collected for one month (November/December 2012) through meat inspection. Secondary data was retrieved from the abattoir records for the period of five years (January 2008 to December 2012). During the one month of prospective study period, a total of 677 cattle were slaughtered at SAAFI abattoir and 45.4% of the livers were condemned due to fasciolosis. At Sumbawanga municipal abattoir 594 cattle were slaughtered, 47.1% of the livers were also condemned due to fasciolosis. The overall prevalence of fasciolosis for five years at SAAFI abattoir was 26.5% (10 592 cattle slaughtered and 2 801 livers were condemned due to fasciolosis) while that of Sumbawanga municipal abattoir was 16.4% (23 612 cattle slaughtered and 3 862 livers were condemned due to fasciolosis). *Fasciola gigantica* was found to be the liver fluke species affecting cattle slaughtered in Rukwa region. The one month (November/December) financial loss due to liver condemnation (Fasciola infected) was Tanzania shilings (TZS) 5 894 400 (USD 3 497) and TZS 5 376 000 (USD 3 190) for SAAFI and Sumbawanga municipal abattoirs, respectively. The public health implication on the quantity of infected livers condemned and the losses incured by livestock and meat traders warrants for more extensive epidemiological investigations to determine the magnitude of the problem in live animals and institution of proper control strategies of fasciolosis in the study area.

**Key words:** abattoir, financial loss, fasciolosis, liver condemnation, SAAFI, Sumbawanga municipal

## INTRODUCTION

Fasciolosis is a disease of ruminants reported to be among the major constraints to ruminant production in different regions of Tanzania (Keyyu *et al*., 2006; Nonga *et al*., 2009). It is among the important parasitic diseases of ruminants particularly in tropical and subtropical countries. *Fasciola hepatica* and *Fasciola gigantica* are the two liver flukes commonly reported to cause fasciolosis in ruminants. *Fasciola hepatica* distribution is mainly in temperate zones, while *F. gigantica* is found in tropical regions of Africa and Asia (Mas-Coma *et al*., 2005; Keyyu *et al.*, 2005).

In Tanzania, the prevalence of fasciolosis has been reported to be 47.6 – 63.8% in traditional cattle (Ecimovic and Mahlau, 1973; Keyyu *et al*., 2006). A study by Hyera (1984) reported abattoir prevalence of *F. gigantica* in cattle in Iringa region to range from 35.5% to 36.5%. Based on retrospective studies, Kambarage *et al*. (1995) and Nonga *et al*. (2009) reported that fasciolosis was responsible for 70% and 52.6% of total liver condemnations in cattle at Morogoro and Arusha abattoirs, respectively.

Fasciolosis is responsible for considerable economic losses in the cattle industry, mainly through mortality, liver condemnation, reduced production of meat, milk and expenditures for antihelmintics (Dargie, 1987; Hillyer and Apt, 1997). For example, Kithuka *et al.* (2002) reported up to USD 0.26 million annual losses attributable to liver condemnations in cattle slaughtered in Kenya. Also Mwabonimana *et al*. (2009) reported an annual loss of USD 56 280 due to fasciolosis at Arusha abattoir in Northern Tanzania.

*Fasciola* infection in cattle occurs mostly through ingestion of contaminated water or pastures in wetland areas. The disease in ruminants manifests as acute, sub-acute or chronic phases. Changes in the liver due to chronic fasciolosis involve thickening of the bile duct, fibrosis and calcification of hepatic tissues (Okaiyeto *et al*., 2012).

Rukwa is among the regions with high population of ruminants especially cattle and has high rains associated with swampy areas which create conducive environment for propagation of *Fasciola*. The main objectives of this study were to determine the prevalence of fasciolosis in cattle slaughtered at Sumbawanga Agricultural and Animal Foods Industries (SAAFI) and Sumbawanga municipal abattoirs and determine financial losses due to liver condemnations.

## MATERIALS AND METHODS

### Study area and animals

The study was conducted at SAAFI abattoir and Sumbawanga municipal abattoir in Rukwa region. SAAFI abattoir is a privately owned facility established in 2007 which is located in Sumbawanga munipality. Rukwa region is located in the Southwest part of Tanzania between Latitudes 5 and 7°S, and Longitudes 31° and 33°E. Ambient temperature ranges from 13°C in some places during June and July to 27°C in October to December. Rainy season starts in October to May and dry season from June to September. Annual rainfall varies from 800 mm to 1300 mm depending on the elevation.

Most of cattle brought for slaughter are adult local breed (Tanzania short horn zebu) and Boran from pastoral and agro-pastoral farming systems within Rukwa region. On rare occasion, crosses of dairy cattle like Friesian, Ayrshire and Jersey are also brought for slaughter as culls. Generally most of the cattle brought for slaughter are males with age ranging from two to five years.

### Postmortem meat inspection and criteria for selection of *Fasciola* cases

Active meat inspection was conducted during the period of November to December 2012 which was during rainy season. Inspection was carried out by visual examination, palpation and incision of the liver on the ventral aspect according to procedures described by Gracey *et al*. (1999). Fasciolosis and lesions were grossly diagnosed based on pathological changes i.e. colour, size, morphology, consistence and presence of lesions and/or parasites. *Fasciola* infection was judged based on liver enlargement with bumpy, raised and/or depressed areas, dark blue to black discolouration, hardness in consistency, enlargement of bile ducts, gritty sound on incision and on the presence of liver flukes. The *Fasciola* cases were grouped as active when live liver flukes were observed and non active when only the above described pathological lesions were present and no live liver flukes. Judgement was based on the extent of infection and pathological lesions. Livers with generalized infection were totally condemned while those with localized infection were trimmed off (partial condemnation) and passed as fit for human consumption. However, the latter were included in the *Fasciola* cases. Liver condemnation information was summarized from the total number of livers inspected. Other causes such as abscesses, hydatidosis, calcified cysts, melanosis and fatty degeneration were also recorded in the postmortem meat inspection reports. These, however, were not used in the financial loss estimations.

### Retrospective data collection

Recorded data on meat inspection for a period of 5 years from January 2008 to December 2012 in the abattoirs were used as sources of data for this study. During this period a total of 10 592 cattle were slaughtered and inspected at SAAFI abattoir while at the Sumbawanga municipal abattoir 23 612 cattle were slaughtered and inspected. At the end of meat inspection every day, all partial and total condemned organs/offal were taken to SAAFI abattoir laboratory for further examination and identification of the lesions and parasites and thereafter were recorded. As means of quality control of data, recorded cases excluded from this study were those with no proper diagnosis of organ/offal and ambiguous information on slaughtered species and slaughter dates.

### Sampling for identification of *Fasciola* species

All livers which had active *Fasciola* infection were set aside for *Fasciola* parasite and bile sampling. A number of *Fasciola* spp. parasites were collected from each liver with active infection and preserved in 70% ethanol during field work. Another duplicate of *Fasciola* spp. parasite samples were collected and put into 4% formalin and vigorously shaken in order to cause muscle fatigue in the worm to prevent excessive contraction. A few *Fasciola* specimen from each liver with active infection were flattened between two glass slides (to facilitate examination) held in position with rubber band and again dropped into 4% formalin. In addition bile was collected from the gall bladder followed by sedimentation to recover the *Fasciola*

eggs and these were preserved in 70% ethanol. All the samples were subsequently transported to the laboratory for identification at the Faculty of Veterinary Medicine, Sokoine University of Agriculture in Morogoro.

**Laboratory processing of samples and identification of *Fasciola* species**

Samples of *Fasciola* collected from the abattoirs were identified through observation of the morphology and measurement of length and width of worms as described by Soulsby (1982). The specimens were examined under sterio microscope at 20 x magnification with a side lamp.

**Laboratory processing of samples and identification of Fasciola eggs**

For further identification of *Fasciola* species, 100 egg samples preserved in 70% ethanol were examined and measured using a compound microscope using 10 x and 40 x objective lens. The length and width of the *Fasciola* eggs were determined and compared with the standard measurements for *F. gigantica* and *F. hepatica.* According to Soulsby (1982), the range of length of *F. gigantica* egg is 156 – 197 µm and width is 90 – 104 µm while *F. hepatica* egg length is 130 – 150 µm and 63 – 90 µm width.

**Financial loss estimation**

Simple random sampling was used to select normal livers for estimating weight. The weight of 100 normal livers were measured using the digital weighing scale for the purpose of estimating the average weight of cattle liver, which was useful during finacial loss calculation. The financial analysis was done for both the prospective and retrospective study. The mean weight of normal livers at the abattoirs was 3.2 kg (ranging from 2.4 to 4 Kg). The annual loss from liver condemnation was assessed by considering the overall prevalence of fasciolosis at the abattoirs, the total annual slaughter of animals and the retail market price of an average bovine liver. The information was subjected to mathematical computation using the formula set by Ogunrinade and Ogunrinade (1980).

$$ALC = MCS \times MLC \times P$$

Where ALC=Annual loss from liver condemnation (direct loss), MCS= Mean annual (number) cattle slaughtered at SAAFI abattoir and Sumbawanga municipal abattoir, MLC= Mean price of one liver in Sumbawanga town in TZS/kg, P= Prevalence of the disease (liver lesions due to fasciolosis) at the study abattoirs.

**Data analysis**

Collected postmortem and meat inspection records were analyzed by Epi-Info Version 6.04b (Centre for disease control, Atlanta, USA). The test statistics used were mean, percentages and chi-square test of independence to compare monthly prevalence of fasciolosis (between the years) encountered at postmortem inspection.

**RESULTS**

**Prevalence of fasciolosis (prospective results)**

A total of 677 cattle were slaughtered at SAAFI abattoir during one month of prospective study and 307 (45.4%) livers were condemned due to fasciolosis. At Sumbawanga municipal abattoir, a total of 594 cattle were slaughtered and inspected out of which 280 (47.1%) livers were condemned due to fasciolosis (Table 1). The overall prevalence of fasciolosis during one month study (November/December) at SAAFI and Sumbawanga municipal abattoir was 46.2%. It was also found that slaughter animals at SAAFI and Sumbawanga municipal abattoirs originated from Nkundi ranch, Ntuchi and Namanyere in Nkasi District, Kaengesa and Muze in Sumbawanga District, Matai and Kalambo ranch in Kalambo District. Other areas were grouped as uncategorised (different farmers around the abattoirs and with unknown origin) (Table 2).

**Table 2**: Prevalence of fasciolosis and other causes of liver condemnation at SAAFI and Sumbawanga municipal abattoirs during one month study from November to December 2012.

| Abattoir | Week | No. of cattle slaughtered | Total no. (%) of liver condemned | Number (%) of livers condemned | |
|---|---|---|---|---|---|
| | | | | Due to fasciolosis | *Other causes |
| **SMA | 1 | 135 | 97 (71.9) | 89 (65.9) | 8 (5.9) |
| | 2 | 119 | 68 (57.1) | 59 (49.6) | 9 (7.6) |
| | 3 | 130 | 72 (55.4) | 56 (43.1) | 16 (12.3) |
| | 4 | 210 | 136 (64.8) | 76 (36.2) | 60 (28.6) |
| | Subtotal | 594 | 373 (62.8) | 280 (47.1) | 93 (15.7) |
| SAAFI | 1 | 218 | 131 (60.1) | 116 (53.2) | 15 (68.7) |
| | 2 | 135 | 66 (48.9) | 53 (39.3) | 13 (9.6) |
| | 3 | 124 | 61 (49.2) | 57 (46.0) | 4 (3.2) |
| | 4 | 200 | 101 (50.5) | 81 (40.5) | 20 (10) |
| | Subtotal | 677 | 359 (53.0) | 307 (45.3) | 52 (7.6) |
| | Total | 1271 | 732 (57.6) | 587 (46.2) | 145 (11.4) |

*Other causes includes: Hydatidosis, abscesses, calcified cysts, fatty degeneration, melanosis and telangiectasis.

**SMA stands for Sumbawanga municipal abattoir

**Prevalence of fasciolosis (retrospective results)**

The retrospective data of five years (2008 -2012) showed that a total of 10 592 cattle were slaughtered at SAAFI abattoir from which 2 801 (26.4%) livers were condemned due to fasciolosis. At Sumbawanga municipal abattoir, a total of 23 612 cattle were slaughtered and inspected, 3 862 (16.4%) livers were condemned due to fasciolosis (Table 3).

**Table 3:** Prevalence of fasciolosis at SAAFI and Sumbawanga municipal abattoirs (SMA) from 2008 to 2012

| Abattoir | Year | No. of cattle slaughtered | No. of livers condemned due to fasciolosis | Prevalence of fasciolosis |
|---|---|---|---|---|
| SAAFI | 2008 | 2461 | 1175 | 47.7 |
| | 2009 | 1710 | 323 | 18.9 |
| | 2010 | 2889 | 426 | 14.7 |
| | 2011 | 1393 | 139 | 10.0 |
| | 2012 | 2139 | 738 | 34.5 |
| | Subtotal | 10592 | 2801 | 26.4 |
| SMA | 2008 | 4093 | 749 | 18.3 |
| | 2009 | 4617 | 687 | 14.9 |
| | 2010 | 4183 | 516 | 12.3 |
| | 2011 | 5297 | 773 | 14.6 |
| | 2012 | 5422 | 1137 | 21.0 |
| | Subtotal | 23612 | 3862 | 16.4 |
| | Total | 34204 | 6663 | 19.5 |

**Other causes of cattle liver condemnation**

Fasciolosis accounted for 75% of liver condemnation during one month study at Sumbawanga municipal abattoir. Other causes which accounted for 25% were hydatidosis, calcified cysts and abscesses, melanosis, congestion, telangiectasis and fatty degeneration. Similarly, at SAAFI abattoir the main causes of liver condemnation during one month study were fasciolosis 86% and other causes accounted for 14% (Table 1).

**Table 4:** Prevalence of fasciolosis according to the origin of cattle during prospective study

| **Origin** | **No. of cattle slaughtered** | **No. of livers condemned due to fasciolosis** | **Prevalence of fasciolosis** |
|---|---|---|---|
| Nkundi ranch | 289 | 160 | 58.5 |
| Kalambo ranch | 456 | 138 | 52.2 |
| Ntuchi/Namanyere | 149 | 87 | 58.4 |
| Kaengesa | 75 | 47 | 62.7 |
| Muze | 113 | 53 | 46.9 |
| Matai | 151 | 84 | 55.6 |
| Uncategorised | 38 | 18 | 47.4 |
| **Total** | **1271** | **587** | **46.2** |

**Laboratory results**

A total of 50 specimens of *Fasciola* worms were examined morphologically and the results showed that all the *Fasciola* specimens were identified as

*F. gigantica*. The length and width of *Fasciola* worms ranged from 25 to 45 mm and 4 to14 mm width. The mean length was 36.7 mm and the mean width was 9.24 mm. A detailed morphological examination of the *Fasciola* specimen revealed that they were transparent, had parallel margins, and long with smaller anterior ends and the shoulders were not prominent. In addition, the size of the eggs of *Fasciola* showed that the length and width ranged from 127.5 to 182.5 µm and 77.5 to 100 µm respectively. The mean length and width of eggs were 158.7 µm and 89 µm respectively. Therefore the mean size of the eggs was 158 µm ± 10.3 by 89 µm ± 4.8 suggestive of *F. gigantica* and *F. hepatica* eggs.

**Financial loss estimation**

**Retrospective study**

At SAAFI abattoir the average annual cattle slaughtered was estimated to be 2 118 while at the Sumbawanga municipal abattoir was 4 722. The mean retail price of bovine liver in Sumbawanga town was 6 000 TZS (Tanzania Shillings) per kg. The mean weight of bovine liver was 3.2 kg. Prevalence of fasciolosis at SAAFI abattoir was 26.4% while that of Sumbawanga municipal abattoir was 16.4%. Therefore the estimated annual loss from liver condemnation was calculated according to the formula:

ALC = MCS * MLC * P

i) SAAFI abattoir
= 2 118 X 6 000TZS X 3.2 kg X 26.4 % = 10 735 720 TZS

ii) Sumbawanga municipal abattoir
= 4 722 X 6 000 TZS X 3.2 kg X 16.4 % = 14 868 330 TZS

The annual financial loss resulted from liver condemnation due to fasciolosis at SAAFI and Sumbawanga municipal abattoir was estimated to be 10 735 720 TZS and 14 868 330 TZS respectively. Therefore the financial loss for the past five years (2008 – 2012) was estimated to be 53 678 600 TZS and 74 341 650 TZS for SAAFI and Sumbawanga municipal abattoirs respectively.

**Prospective study**

Prospective study was done for one month and the financial loss due to liver condemnation was calculated as the product of the price of one liver and the total number of livers condemned. The mean weight of one liver at the slaughter abattoirs was 3.2 kg and the average price was 6 000 TZS per kg.

SAAFI abattoir = 307 X 6 000TZSX3.2 kg = 5 894 400 TZS.

Sumbawanga municipal abattoir = 280 X 6 000TZSX3.2 kg = 5 376 000 TZS.

Therefore the one month (November/December) financial loss due to liver condemnation (Fasciola infected) was 5 894 400 TZS and 5 376 000 TZS for SAAFI and Sumbawanga municipal abattoirs respectively.

## DISCUSSION

The result of the one month study indicated a condemnation rate of livers due to fasciolosis of 45.4% at SAAFI abattoir while that of Sumbawanga municipal abattoir was 47.1%. The five year (2008-2012) retrospective record also indicated the liver condemnation rate due to fasciolosis to be 26.4% and 16.4% for SAAFI and Sumbawanga municipal abattoir respectively. The overall prevalence of fasciolosis is high at the two investigated abattoirs. This reflects probably the existence of favourable conditions for the intermediate host snail to survive and keep on transmitting the parasite to the environment affecting more animals.

It is known that the pattern of *Fasciola* infection in cattle is a reflection of the timing and duration of ecological circumstances favourable for the population of snails and survival of metacercariae, as well as the management of livestock (Spithill *et al.*, 1999). During the dry seasons, grazing of cattle is done in lowland marshy areas with stagnant water in ponds which favour the survival and multiplication of intermediate host snails.

The liver condemnation rates observed in the current study were higher than that reported by Mwabonimana *et al.* (2008) who observed a

condemnation rate of livers due to fasciolosis of 10.8% at Arusha abattoir. Also Mellau *et al.* (2010) recorded a lower liver condemnation rate (8.6%) due to fasciolosis at Arusha abattoir. However, in some areas of Tanzania the prevalence has been found to be higher than findings of this study. For example, Keyyu *et al.* (2006) reported up to 100% liver condemnation rates in some slaughter slabs in rural areas in Iringa due to liver flukes in cattle. Similarly, a survey in Morogoro and Hai in Tanzania, Mekelle in Ethiopia and Kafue in Zambia recorded a prevalence of 70%, 14%, 24.3% and 41.3%, respectively (Kambarage, 1995; Phiri *et al.*, 2005; Swai and Ulicky, 2009; Berhe *et al.*, 2009). High rate of liver condemnation due to fasciolosis observed by this study has serious financial losses to farmers, livestock and meat traders and is a drawback to livestock industry in the country. Fasciolosis being an emerging zoonotic disease may also pose health risks to the meat consumers and those eating raw vegetables (salads) in Rukwa. This justifies for strengthening fasciolosis surveillance in the live animals and also transmission sites to better determine the magnitude of the problem, possible financial impact it causes and public health consequences.

From the retrospective study, an annual loss of about 10 735 720 TZS and 14 868 330 TZS was estimated at SAAFI and Sumbawanga municipal abattoir respectively. However the prospective study, indicated a loss at SAAFI and Sumbawanga municipal abattoirs of 5 894 400 TZS and 5 376 000 TZS respectively. These should be regarded as underestimation of overall losses caused by fasciolosis as the infection also results into loss of body condition (hence lower carcass weight), which would add to further financial losses.

Moreover, losses due to trimming of affected parts of livers were not taken into account due to poor recording at the abattoirs. Similar study was done at Arusha abattoir and reported an annual financial loss of 67 536 000 TZS (approximately USD 56 280) (Mwabonimana *et al.*, 2008). In Ethiopia, abattoir studies reported an average of 148.12 and 54 063 34 Ethiopian birr (USD 5 429 and USD 5 631 598) per day and annum, respectively (Tadele and Worku, 2007). Fasciolosis is of great economic significance worldwide with losses estimated to exceed 2 000 million dollars yearly, affecting more than 600 million animals. The disease is responsible for considerable economic losses in the cattle industry, mainly through mortality, liver condemnation, reduced production of meat, milk and expenditures on antihelmintics (Dargie, 1987; Hillyer and Apt, 1997). Apart from the economic losses, fasciolosis also reduces sources of protein through condemnation of livers which could otherwise be used as nutritious food to agropastoral society in Rukwa.

It was further observed that there were differences in the prevalence between retrospective data (SAAFI 26.4%; Sumbawanga abattoir 16.6%) compared to the prospective data (SAAFI 45.4%; Sumbawanga abattoir 47.1%). This suggests that number of recorded cases were lower compared to the actual situation. This can be attributed to trimming of the *Fasciola* infected livers and that are passed as fit for human consumption and therefore not recorded as *Fasciola* cases. Also poor recording system at the abattoirs may contribute to the lowered prevalence of fasciolosis. Probably some of the condemned organs were taken out for black market by unfaithful abattoir workers and were not recorded, which is of public health concern on the legitimate use of liver as food to consumers, also, may lower the financial value of the product. A better recording system and adherence to the ethics of meat inspection are required in order to obtain proper data.

The study identified the species causing fasciolosis in cattle at SAAFI and Sumbawanga municipal abattoir to be *F. gigantica.* This is in line with the findings by Keyyu *et al.*, (2005) that *Fasciola* and amphistomes are endemic in Iringa (Southern highland). The disease is also prevalent in Mwanza, Geita, Shinyanga and Kigoma regions in Tanzania (Hyera, 1984). *Fasciola gigantica* is the common *Fasciola* species found in Africa and Asia (Wamae *et al*., 1998) and is widely distributed in tropical and subtropical areas where it is recognized as a major cause of production losses in domestic ruminants (Hammond and Sewel, 1990; Mage *et al*., 2002). However, morphometric measurements of *Fasciola* eggs obtained from the gall bladder of infected livers showed a range of the length of 127 to 182.5 micrometres and the range of width of eggs being 77.5 to 100 micrometres suggesting that both *F. gigantica* and *F. hepatica* species are present. Studies carried out at Kitulo farm in Njombe region indicated the presence of *Galba (Lymnaea) trancatula* and *F. hepatica* using morphometric and molecular data (Walker *et al.*, 2008). More work is required to confirm the existence of *F. hepatica* and its intermediate host in Rukwa region.

Fasciolosis is an emerging zoonotic disease which poses a great threat to the public health. The prevalence of zoonotic helminth infections in human in any region is directly associated with the prevalence of infections in the animal population in that region (Ekong *et al*., 2012). The 1999 global estimates suggest that up to 2.4 million or even up to 17 million people (Hopkins, 1992) were infected with *F. hepatica* (Rim *et al*., 1994). Global analysis of the geographical distribution of human cases shows that there was correlation between animal and human fascioliasis. Similarly, El-Khoby, (1997) and Farag, (1997) in Egypt reported a problem of fasciolosis in human to be an emerging health problem especially in people living in rural areas which had a prevalence ranging from 7 to 17%. High prevalence of fasciolosis in animals may suggest that fasciolosis might also be present in humans. Therefore, it is likely that there is high risk of *Fasciola* infection to people in Rukwa region. Uncontrolled *Fasciola* infections may result in perpetual contamination of the environment and increased burden of infection in both animal and human. Proper control of fasciolosis in animals and the intermediate host snail in the environment would reduce the risk of zoonosis in Rukwa region. Study to establish existence of the disease (zoonosis) is warranted.

From the results of the study, it is therefore concluded that fasciolosis caused by *F. gigantica* is an important disease in Rukwa region and that it causes considerable loss of revenue due to condemnation of affected cattle livers. This has a negative socio-economic impact on the development of livestock industry and public health welfare due to its zoonotic nature. There is therefore a need to develop a helmith control strategy which is likely to target better livestock management systems and malacological mapping (intermediate host snail area mapping).

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