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Abstract not exceeding 200 words giving a synopsis of the findings presented and the conclusion(s) reached.

Introduction stating the purpose of the work.

Materials and Methods used.

Results presented concisely.

Discussion of significance.

Acknowledgements.

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TRYPANOSOMA CONGOLENSIS INFECTION IN SHEEP: BLOOD VOLUMES, ERYTHROKINETICS AND ALBUMIN METABOLISM

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INFECTION PAR TRYPANOSOMA CONGOLENSIS CHEZ LES MOUTONS: VOLUMES DU SANG, ERYTHROCINETIQUE ET METABOLISME DE L'ALBUMINE

Résumé
La présente étude a été menée en vue de déterminer les changements de volumes du sang, de la cinétique de l'hématie et du métabolisme de l'albumine chez les moutons Scottish Blackface, 75 jours après l'infection par Trypanosoma congoense. L'on a observé que les animaux infectés avaient une moyenne plus faible des volumes d'hématies circulant et une moyenne plus courte de la durée de vie des hématies que les animaux-témoins. Les volumes du plasma, les volumes du sang entier et le taux d'échappement transcapillaire de l'albumine étaient plus élevés chez les animaux infectés que chez les sujets-témoins, alors que la concentration d'albumine dans le plasma était plus faible chez les animaux infectés, comparé aux sujets-témoins. Toutefois, la réserve d'albumine totale en circulation n'était pas affectée par l'infection. La présente étude n'a pas révélé si l'hémodilution était un résultat de l'hypoalbuminémie et si elle a légèrement augmenté le taux d'échappement transcapillaire de l'albumine. Les animaux infectés ont manifesté une activité erythropoïétique accentuée comme le montraient les taux plus élevés d'incorporation Fe et les taux de renouvellement du fer du plasma par rapport aux animaux-témoins.

Il a été conclu que, 75 jours après l'infection, l'anémie était due à la perte accélérée des hématies de la circulation et à l'hémodilution, et qu'il n'y avait pas de preuve de dyshématopoïèse.

Abstract
The present study investigated the changes in blood volumes, red cell kinetics and albumin metabolism in Scottish Blackface sheep 75 days after infection with Trypanosoma congoense. It was observed that infected animals had lower mean circulating red cell volumes and shorter mean estimated red cell lifespans than control animals. Plasma volumes, total blood volumes and transcapillary escape rate of albumin were higher in infected animals than in control animals while plasma albumin concentration was lower in the former than in the latter. However, total albumin pool in the circulation was not affected by infection. It was not clear from the current study whether haemodilution was a result of hypoalbuminaemia and moderately increased transcapillary escape rate of albumin. Infected animals showed enhanced erythropoietic activity as judged by higher Fe incorporation rates and plasma iron turnover rates than in control animals.

It was concluded that anaemia at 75 days after infection with Trypanosoma congoense was due to accelerated red cell loss from the circulation and haemodilution and there was no evidence of dyshaemopoiesis.

Introduction
Anaemia is recognised as the most important clinicopathological feature of both naturally occurring or experimentally induced animal trypanosomiasis. However, the underlying mechanisms of anaemia are poorly understood despite numerous studies which have been conducted predominantly in mice and cattle. Studies in cattle suggest that haemodilution increased red cell destruction and dyshaemopoiesis or a combination of these factors may be responsible for the anaemia. In sheep infected with T. vivax, Clarkson recorded an expansion in plasma volumes but total blood volumes were unaltered. On the other hand, Anosa and Isoun recorded significant increases in both plasma and blood volumes in sheep and goats infected with T. vivax. It is possible that the three mechanisms namely, haemodilution, haemolysis, and dyshaemopoiesis operate at different stages
and to different degrees during a course of trypanosome infection.

The present study was conducted to investigate the mechanisms of anaemia and also to explore the possible relationship between the changes in plasma volume and albumin metabolism in sheep, 11 weeks after infection with *Trypanosoma congolense*.

**Materials and Methods**

**Experimental Animals**

Ten male Scottish Blackface lambs, six months old were purchased from a local hill farm in the west of Scotland. The animals were housed in a fly proof isolation unit and were dosed with a 2.5% suspension of fenbendazole at a dose rate of 5 mg/kg.

**Housing and Feeding**

The animals were loose housed and were kept on wood shavings. Each animal received 500 g dry concentrate feed (306 Ewbol Store Lamb Finisher pellets, BOCM. Silcock). Hay and water were available ad libitum.

**Trypanosomes and preparation of the inoculum**

The sheep were infected with *Trypanosoma congolense* 1180 which is an isolate made from a lion in the Serengeti. The trypanosomes were raised in irradiated mice and were harvested at the peak of first rising parasitaemia. The mice were bled by cardiac puncture and their blood was pooled. An estimate of parasitaemia was made on the pooled sample and was then diluted with phosphate buffered saline (PBS) containing 1.5% glucose to give about 105 trypanosomes in 3 ml of PBS. Each infected animal then received 105 trypanosomes in 3 ml of PBS by the jugular route.

**Preparation, Injection of and Sampling for Radioisotopes**

The techniques used for preparing Chromium labelled red cells (Cr-red cells), Iodine labelled albumin (I-albumin) and Ferric-citrate (Fe) have been described by Holmes and Maclean and Dargie et al. Each animal received 4 MBq of 51Cr, 1.85 MBq of 59Fe and 9 MBq of 55Fe by intravenous injection. Blood was collected before injection of radioisotopes and at 10, 30, 60, 90 and 120 minutes after injection. Thereafter samples were collected once daily for one week and three times a week for the following two weeks.

Blood for serum was collected into iron-free tubes without an anticoagulant and serum was separated 24 hours after centrifugation at 700g for 20 minutes.

One ml of blood and one ml of plasma were diluted with 9 ml of sodium hydroxide for determination of radioactivity in a gamma scintillation counter (Packard instruments).

**Blood Examination and Estimation of Parasitaemia**

Methods used to examine blood and estimation of parasitaemia have been described. Briefly, packed red cell volume, red cell counts and mean corpuscular volumes were determined using a standard blood cell counting machine (BX Minos, Roche Diagnostica) and parasitaemia was estimated by the darkground buffy coat method and the intensity of parasitaemia was graded from 0 to 6 as described by Paris et al. Plasma albumin concentration was measured by continuous flow analysis (Standard Technicon Autoanlyser II Method).

**Blood Volumes**

Red cell volume and plasma volumes were measured using 51Cr-red cells and 125I-albumin using the dilution method as described by Dargie et al. Blood volume was calculated as the sum of red cell volume and plasma volume.

**Erythrokinetics**

Red cell survival was assessed using 51Cr-red cells as described by Dargie et al. and red cell synthesis was assessed on the basis of the rate of plasma iron turnover (PITR) and red cell iron
utilisation as described by Bothwell et al.\textsuperscript{13}. The red cell iron incorporation rate was obtained as the product of percentage utilisation of radioiron and PITR and the red cell lifespan was calculated as described by Dargie et al.\textsuperscript{9}.

**Intravascular Pool of Albumin (CA)**
The intravascular pool of albumin was obtained by multiplying the plasma albumin concentration (g\textsuperscript{l-1}) by the plasma volume (1) and dividing the result by the body weight (kg). This was expressed as g[kgBW]\textsuperscript{-1}.

\[
\text{Plasma volume (1) x plasma albumin (g\textsuperscript{l-1})} = \frac{\text{CA(g[kgBW]\textsuperscript{-1})}}{\text{Body weight (kg)}}
\]

**Transcapillary Escape Rate of Albumin**
Transcapillary escape rate of albumin (TER\textsubscript{alb}) was calculated by the formula of Paring and Guntelberg (cited by Holmes, 1976)\textsuperscript{2}:

\[
\text{TER alb (\%h) =} \frac{0.693}{T_{1/2}(h)}
\]

**Experimental design**
Ten animals were involved in the study. They were randomly divided into two groups of five animals each. One group (infected group) was injected with 1x10\textsuperscript{5} *Trypanosoma congoense* by the intravenous route while the other group served as the uninfected controls. Seventy-five days after infection, all animals were injected with the three radioisotopes namely, \textsuperscript{125}I-albumin, \textsuperscript{51}Cr and \textsuperscript{59}Fe-Ferric citrate to measure blood volumes, red cell survival and red cell synthesis. They were observed for a further three weeks.

**Statistical Methods**
Data were evaluated using one way analysis of variance on an IBM computer by the Minitab Program. Significance was considered where P<0.05. All results are presented as mean (standard error of the mean) (sem).

**Results**

**Haematological Observations**
At 75 days after infection, the mean packed red cell volume (PCV) values in infected animals had dropped to 0.27±0.02 1\textsuperscript{-1} while it was 0.33±0.01 1\textsuperscript{-1} in control animals (Figure 1).

The red blood cell counts (RBC) and mean corpuscular volume (MCV) values in infected animals were 7.46±0.32x10\textsuperscript{12} 1\textsuperscript{-1} and 37.2±0.6 fl respectively while in control animals, they were 9.89±0.10 x 10\textsuperscript{12} 1\textsuperscript{-1} and 31.8±0.3 fl respectively.

**Parasitological Findings**
After a prepatent period of seven to nine days, the mean parasitaemia infected sheep increased to reach the first peak by 16 days after infection (Fig. 1). Thereafter it fluctuated considerably but showed continually decreasing peaks after 49 days after infection and was at its lowest by 75 days after infection.

**Blood Volumes**
The red cell volumes, plasma and total blood volumes of infected and control animals are shown in Table 1. Infected animals had significantly lower circulating red cell volumes (12.8±0.8 vs 15.9±1.3 mlkg\textsuperscript{-1}) compared to the uninfected controls. The mean plasma volume in infected animals was 26.4 percent higher than that in control animals.

<table>
<thead>
<tr>
<th></th>
<th>Red cell volume</th>
<th>Plasma volume</th>
<th>Blood volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>(mlkg\textsuperscript{-1})</td>
<td>(mlkg\textsuperscript{-1})</td>
<td>(mlkg\textsuperscript{-1})</td>
<td></td>
</tr>
<tr>
<td>Infected</td>
<td>12.8 ± 0.8</td>
<td>45.1 ± 1.5</td>
<td>57.9 ± 1.1</td>
</tr>
<tr>
<td>Control</td>
<td>15.9 ± 1.3</td>
<td>36.2 ± 1.0</td>
<td>52.1 ± 2.2</td>
</tr>
<tr>
<td>Significance</td>
<td>P&lt;0.05</td>
<td>P&lt;0.01</td>
<td>P&lt;0.001</td>
</tr>
</tbody>
</table>
Figure 1: Parasitaemia scores and packed red cell volumes of sheep infected with *Trypanosoma congolense* (○○○) and of uninfected control sheep (– · · · · · ·). T denotes treatment.

**Results**

Plasma volumes were also calculated using corrected $^{125}$I and $^{59}$Fe counts at 0 and 10 minutes after injection of radioisotopes. These values are shown in Table 2. It was observed that plasma volumes of infected animals calculated with either isotope at $T_0$ were similar, however plasma volumes obtained with $^{59}$Fe at $T_{10}$ were significantly higher than the values at $T_0$ in both infected and control animals. Considering plasma volume values obtained with counts at $T_{10}$ compared to those at $T_0$ it was evident that $^{59}$Fe significantly overestimates plasma volumes of both infected and control animals, with the greatest effect being in infected animals. Plasma volumes obtained with $^{125}$I at $T_0$ and $T_{10}$ were similar in both infected and control animals.

**Erythrokinetics**

Table 3 shows $^{51}$Cr red cell half-lives, RBC $^{59}$Fe-inorporation rates, PITR and estimated red cell life span of infected and non-infected animals. The $^{51}$Cr-RBC half-lives and estimated red cell lifespan were lower in infected animals ($9.2 \pm 0.5$ d and $47.2 \pm 11.8$ d respectively) than in uninfected control animals ($13.3 \pm 0.4$ d and $116.0 \pm 6.2$ d). On the other hand, PITR was significantly higher in infected animals ($0.62 \pm 0.8$ mg kg$^{-1}$ d$^{-1}$) than in control animals ($0.32 \pm 0.01$ mg kg$^{-1}$ d$^{-1}$). Infected animals also had higher $^{59}$Fe incorporation rates ($0.43 \pm 0.7$ mg kg$^{-1}$ d$^{-1}$) than control animals ($0.17 \pm 0.01$ mg kg$^{-1}$ d$^{-1}$).
Table 2: Plasma volumes of sheep infected with *Trypanosoma congolense* and of uninfected control sheep measured with corrected $^{59}$Fe and $^{125}$I-albumin at 0 and 10 minutes after injection of radioisotopes (mean ± sem)

<table>
<thead>
<tr>
<th></th>
<th>$^{59}$Fe</th>
<th></th>
<th>$^{125}$I-albumin</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$T_0$</td>
<td>$T_{10}$</td>
<td>$T_0$</td>
<td>$T_{10}$</td>
</tr>
<tr>
<td>Infected</td>
<td>46.0 ± 1.1</td>
<td>50.6 ± 1.3$^*$</td>
<td>45.1 ± 1.5</td>
<td>45.8 ± 1.6$^c$</td>
</tr>
<tr>
<td>Control</td>
<td>39.2 ± 0.8</td>
<td>41.4 ± 1.0$^a$</td>
<td>36.2 ± 1.0$^b$</td>
<td>36.5 ± 1.0</td>
</tr>
</tbody>
</table>

$^*$ Significantly different from corresponding value at $T_0$
$^a$ Significantly different from the $^{59}$Fe value at $T_0$
$^b$ Significantly different from the $^{59}$Fe value $T_{10}$

Table 3: Red cell survival and plasma iron kinetics of sheep infected with *Trypanosoma congolense* and of uninfected control sheep (mean ± sem)

<table>
<thead>
<tr>
<th></th>
<th>$^{51}$Cr-RBC</th>
<th>PITR</th>
<th>RBC $^{59}$Fe</th>
<th>RBC Lifespan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$T_{1/2}$(d)</td>
<td>(mgkg$^{-1}$'d$^{-1}$)</td>
<td>I.R. (mgkg$^{-1}$'d$^{-1}$)</td>
<td>(d)</td>
</tr>
<tr>
<td>Infected</td>
<td>9.2 ± 0.5</td>
<td>0.62 ± 0.08</td>
<td>0.43 ± 0.07</td>
<td>47.2 ± 11.8</td>
</tr>
<tr>
<td>Control</td>
<td>13.3 ± 0.4</td>
<td>0.32 ± 0.01</td>
<td>0.17 ± 0.01</td>
<td>116.0 ± 6.2</td>
</tr>
<tr>
<td>Significance</td>
<td>P&lt;0.001</td>
<td>P&lt;0.01</td>
<td>P&lt;0.01</td>
<td>P&lt;0.001</td>
</tr>
</tbody>
</table>

PITR = Plasma iron turnover rate
I.R. = Incorporation rate

**Albumin Metabolism Studies**

Infected animals had shortened $^{125}$I-albumin half life (13.4 ± 0.5 d) and lower plasma albumin concentration (32.8 ± 1.3 g1$^{-1}$) than control animals (18.8 ± 0.8 d and 38.4 ± 0.8 g1$^{-1}$ respectively), (Table 4). The intravascular pool of albumin was similar in infected and control animals (1.48 ± 0.07 vs 1.38 ± 0.02 g1$^{-1}$), however infected animals had higher transcapillary escape rate of albumin (5.20 ± 0.18%/h) than control animals (3.70 ± 0.30%/h)

**Discussion**

The present study has confirmed that sheep with *Trypanosoma congolense* develop macrocytic normochromic anaemia and that the anaemia is associated with an expansion in the plasma volume, total blood volume and enhanced erythropoietic activity as determined by plasma iron turnover rates and $^{59}$Fe incorporation rates. Observation of anaemia at 75 days after infection is in agreement with the reports of Losos and Ikede$^{14}$ and Clarkson$^b$

Table 4: Albumin metabolism studies in sheep infected with *Trypanosoma congolense* and of uninfected control sheep (mean ± sem)

<table>
<thead>
<tr>
<th></th>
<th>$^{125}$I-albumin</th>
<th>Plasma albumin (g1$^{-1}$)</th>
<th>CA (gkg$^{-1}$)</th>
<th>TERAlb (%h$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$T_{1/2}$(d)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infected</td>
<td>13.4 ± 0.5</td>
<td>32.8 ± 1.3</td>
<td>1.48 ± 0.07</td>
<td>5.20 ± 0.18</td>
</tr>
<tr>
<td>Control</td>
<td>18.8 ± 0.8</td>
<td>38.4 ± 0.8</td>
<td>1.38 ± 0.02</td>
<td>3.70 ± 0.30</td>
</tr>
<tr>
<td>Significance</td>
<td>P&lt;0.001</td>
<td>P&lt;0.001</td>
<td>P&lt;0.05</td>
<td>P&lt;0.01</td>
</tr>
</tbody>
</table>

**Note:**
- All measurements are given as mean ± standard error.
- Statistical significance was determined using the Student's t-test.
- $P<0.05$ indicates a significant difference between groups.
in sheep infected with *T. vivax* and confirms our previous observations in sheep infected with *Trypanosoma congolense*. While it is recognised that anaemia is a prominent feature of animal trypanosomiasis, several aspects of its aetiology remain unclear. The information provided by the current study is unique in that for the first time, a direct assessment of the changes in blood volumes, red cell kinetics and ferrokinetics have been performed at the same time in sheep chronically infected with *Trypanosoma congolense*.

Measurement of blood volumes has shown that infected sheep had lower circulating red cell volumes but higher plasma and total blood volumes than control sheep. In a comparable study in sheep infected with *T. vivax*, recorded an increase in both plasma and total blood volumes. However, Clarkson reported an increase in plasma volume but total blood volumes were unchanged. These observations suggest haemodilution may be an important factor in the development of anaemia in chronic *Trypanosoma congolense* infection. The actual causes of an expansion in plasma volume have not been investigated and as such remain unknown. It is known that plasma albumin is important in the regulation of plasma osmotic pressure. It is, therefore, anticipated that a decrease in plasma albumin concentration as occurs in trypanosomiasis, may cause a decrease in plasma osmotic pressure hence allowing movement of fluid into the circulatory system. It is interesting to note that while plasma albumin concentration decreased by 14.6% in infected animals compared to the control, the increase in plasma volume was 26.4%. It is therefore possible that the increase in plasma volume may be disproportionate with respect to the decrease in plasma albumin, suggesting that other factors, in addition to hypoalbuminaemia may be responsible for an increase in plasma volume.

Clarkson has suggested that an increase in plasma volume may be due to a marked increase in the concentration of gamma globulins recorded in animal trypanosomiasis, where they may act as plasma expanders by increasing plasma colloid osmotic pressure. However, globulins due to their large particle size are not highly osmotic, hence their role in the aetiology of haemodilution remains unresolved.

Some workers have suggested that high plasma volumes may be recorded in trypanosomiasis infections because of increased vascular permeability. The possibility that capillary permeability may be altered in *Trypanosoma congolense* infection was investigated, in the present study, by measuring the transcapillary escape rate of albumin. It was observed that the TER was moderately higher in infected animals (5.20 ± 0.18%/h) than in control animals (3.70 ± 0.30%/h). The formula used to calculate the TER was based on the half life of 125I-albumin and could easily give erroneous results especially where the half life of 125I-albumin may be influenced by factors other than vascular permeability. It is possible that an expanded plasma volume may affect the half life of 125I-albumin. Holmes suggested that the changes in plasma albumin and the shortened half life of 125I-albumin are mainly due to the dilution effect of an increased plasma volume. He based his suggestion on failure to demonstrate higher radioactivity of 125I-albumin in urine of animals infected with *Trypanosoma congolense* compared to the uninfected controls. The observation of similar total albumin pool in infected and control animals, in the current study, lends more support to the suggestion of Holmes that haemodilution may be responsible for hypoalbuminaemia in trypanosomiasis infected animals.

Dargie et al. suggested that results of plasma volumes may vary depending on which method was used. He suggested that using 59Fe would lead to erroneously high readings. This possibility was investigated by comparing plasma volumes obtained by using either 59Fe or 125I-albumin. It was observed that both isotopes gave similar results in infected and control animals when the corrected counts were extrapolated to time zero. However, 59Fe counts at T0 overestimated plasma volumes particularly of infected animals. Plasma volumes obtained with 125I-albumin using counts at T0 and
T₁₀ were similar. This could be due to the fact that the rate of removal of ¹²⁵I-albumin from the circulation is slower than that of ⁵⁹Fe especially in anaemic animals. These observations suggest that both isotopes could be used to measure plasma volumes in sheep as long as the corrected counts extrapolated to T₀ are used.

Infected animals in the current study had lower circulating red cell volumes and ⁵¹Cr-red cell half lives than control sheep. These observations are in agreement with accelerated red cell loss from the circulation. Similar findings have been reported in cattle infected with T. vivax²,³,⁹ Most evidence supports the view that extravascular haemolysis and associated erythropagocytosis are largely responsible for the anaemia in animal trypanosomiasis¹,¹⁷. It has been proposed that erythropagocytosis may be a result of coating of red cells with trypanosoma antigens or antibody, damage by haemolytic factors produced by trypanosomes, fever, disseminated intravascular coagulation, and production of antibodies against normal red cells¹.

Studies with ⁵⁹Fe have shown that infected sheep had higher PITR and rate of ⁵⁹Fe incorporation than control animals, suggesting that erythropoietic activity was enhanced in infected animals. Similar observations have been reported in cattle infected with T. vivax³,¹⁸. These observations suggest that dyshaemopoiesis is not a feature of trypanosomiasis in sheep at this stage of infection.

The present study had indicated that sheep which are chronically infected with Trypanosoma congolense develop anaemia which is associated with accelerated red cell loss from the circulation and haemodilution. Ferrokinetic studies confirm that erythropoiesis is enhanced but does not fully compensate for accelerated red cell loss, hence low haematocrit values persist in chronic infections.

Acknowledgements
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References
BOVINE FASCIOLA INFECTION SURVEY IN UGANDA

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ENQUETE SUR L’INFECTION BOVINE PAR FASCIOLA EN OUGANDA

Résumé
On a examiné des prélèvements fécaux de 650 bovins en élevage traditionnel dans les districts de Bugiri, Pallisa, Masindi et Ntungamo, afin de déterminer la présence des œufs de Fasciola. Par ailleurs, on a reçu 382 foies de bovins abattus sur une période de 17 mois dans les abattoirs des districts de Mbane, Tororo et Busia. Sur les 650 bovins examinés, 174 (26,8%) étaient infectés par Fasciola gigantica. La prévalence de l’infection par Fasciola a augmenté avec l’âge comme suit: 12.5% chez les veaux de moins de 6 mois; 21.6% chez les veaux de 6-12 mois; 22.6% chez les bovins de 13-24 mois et 30.3% chez les bovins de plus de 24 mois. La prévalence de l’infection par Fasciola était la plus forte chez les bovins dans le district de Masindi (45%), suivie par le district de Bugiri (29,3%), le district de Pallisa (19,2%) et le district de Ntungamo (14,6%). Parmi les 382 foies, 138 (36%) étaient infectés par Fasciola gigantica. La forte prévalence de l’infection par Fasciola chez les bovins en élevage traditionnel en Ouganda nécessite de recourir d’urgence à un programme de lutte, étant donné que les agriculteurs qui pratiquent l’élevage bovin sous système traditionnel n’effectue pas de contrôle systématique des infections par Fasciola.

Abstract
Faecal samples from 650 cattle kept under traditional management obtained from Bugiri, Pallisa, Masindi and Ntungamo Districts were examined for Fasciola eggs. In addition, 382 livers of slaughtered cattle were obtained over a period of 17 months from abattoirs in Mbane, Tororo and Busia Districts in Uganda. Of the 650 cattle examined, 174 (26.8%) were infected with Fasciola gigantica. The prevalence of Fasciola infection increased with age as follows: 12.5% in calves below six months, 21.6% in calves of 6-12 months, 22.6% in cattle of 13-24 months and 30.3% in cattle older than 24 months. The prevalence of Fasciola infection was highest in cattle in Masindi District (45%), followed by Bugiri District (29.3%), Pallisa District (19.2%) and Ntungamo District (14.6%). Of the 382 livers, 138 (36%) were infected with F. gigantica. The high prevalence of Fasciola infection in traditionally managed cattle in Uganda calls for urgent attention in terms of an established control programme, given that farmers keeping cattle under traditional management do not practise routine control of Fasciola infections.

Introduction
Bovine Fasciola infection is diagnosed mainly at slaughter in cattle in many areas of Uganda. The debilitation and emaciation caused by the infection in cattle leads to production losses in terms of weight loss, reduced draught power output and ill-health due to anaemia. Condemnation of livers further leads to economic loss. Though these losses have not been quantified in Uganda, Fasciola infection is reported to be responsible for 46% of the liver condemnation in Tanzania and 20% in Kenya. Fluke infections in cattle at all ages up to six months are known to reduce performance. In addition, Fasciola infection leads to poor feed conversion, retarded growth and is known to depress milk production by 6-30%.

Many changes in the grazing management and breed composition of cattle have taken place in Uganda in the last 30 years. These changes have probably led to variations in the distribution of bovine Fasciola infection in Uganda. However, the existing records on the infection in Uganda date back to the 1970s. It was, therefore, necessary to determine the current distribution of the infection to provide information for control measures. This paper reports on surveys carried out in Bugiri, Pallisa, Masindi and Ntungamo Districts and liver inspections carried out in abattoirs in Mbane, Tororo and Busia Districts in Uganda.
Materials and Methods

Study area
Bugiri District was selected to represent wetlands along Lake Victoria, while Pallisa District represented wetlands along Lake Kyoga and Masindi represented wetlands along Lake Albert. Ntungamo represented swampy areas in western Uganda. Liver inspections in abattoirs in Tororo, Mbale and Busia Districts enabled assessment of the prevalence of Fasciola infection in cattle in the different districts of origin traced by use of abattoir records on cattle origin. Bugiri, Busia, Katakwi, Kumi, Masindi, Mbale, Moroto, Ntungamo, Pallisa, Soroti and Tororo Districts are shown on the map below (Fig. 1).

Cattle
Cattle examined in Bugiri and Pallisa were mainly of the Zebu breed kept under traditional management by open grazing and tethering.

Cattle examined in Masindi were mainly of the Ankole breed, a few cross-breeds and Zebu kept in fenced farms but a few kept under traditional management. Cattle examined in Ntungamo District were of the Ankole breed kept under traditional management and a few cross-breeds kept in fenced farms.

Sampling
At least 150 cattle in eight to ten herds grazing in wetlands in three subcounties (at least two herds per subcounty) in each district visited were included. All cattle in selected herds were examined. Faecal samples were obtained per rectum, packed in plastic bags clearly labelled and kept on ice until examined within six to 12 hours. Blood samples for serological analysis were obtained from each animal from the jugular vein. The age of each animal was determined based on the authors' evaluation and owners' records, where available.

Figure 1: Map of Uganda showing districts within the study area. Note: though Iganga is shown on the map, results are only shown for Bugiri which used to be part of Iganga District.
Faecal examination

Faecal samples were examined for Fasciola eggs using the sedimentation technique as described by Hansen and Perry.

Liver inspection

Liver inspections were carried out at abattoirs in Tororo, Mbaale and Busia Districts from February 1997 to August 1998. The inspection was based on visual observation of the presence of Fasciola parasites in the liver of animals after slaughter. Data on the district of origin of each animal was extracted from abattoir records.

Statistical analysis

The prevalence of the Fasciola infection in the different age groups was compared using the Chi-square Test performed using the computer package EPI INFO 6 version 6.02.

Results

Field samples

Table 1 shows the prevalence of Fasciola infections based on the detection of Fasciola eggs in faecal samples of cattle in different age groups in different districts visited. Generally, the prevalence of the infection increased with age; calves below six months, 12.5%, calves six - 12 months, 21.6%, cattle of 13-24 months, 22.3% and cattle of above 24 months, 30.3%. However, there was no significant difference (Chi^2 = 0.02; P>0.05) in the prevalence between calves aged six - 12 months and cattle aged 13-24 months. Neither was there any significant difference in the prevalence between calves below 6 months and those aged 6-12 months (Chi^2 = 1.96; P>0.05) nor between cattle aged 13-24 months and those of above 24 months (Chi^2 = 3.03; P>0.05). Of all the 650 cattle examined during the field survey, 174 (26.8) had the infection. Of the animals examined in Masindi, Bugiri, Pallisa and Ntungamo, 68 (45%), 49 (29.3%), 35 (19.2%) and 22 (14.6%) had the infection respectively.

Slaughter cattle at abattoirs

Table 2 shows the prevalence of Fasciola infection based on liver inspection at abattoirs in Tororo, Mbaale and Busia Districts. Data on the origin of cattle slaughtered in these districts indicated that the animals came from Busia, Tororo, Mbaale, Kumi, Soroti, Katakwi, Moroto and Kotido Districts. Over 17 months, 36% of the 382 cattle examined in abattoirs had Fasciola parasites in the livers. Most of the animals slaughtered came from Tororo (218), Katakwi (94) and Kumi (30). Fewer came from Kotido (ten), Mbaale (eight), Busia (eight), Soroti (eight) and Moroto (six). Despite the small number of animals from some districts, Fasciola parasites were detected in animals from all districts of origin apart from Busia and Moroto. Of the animals examined, 26 (27.6%) of those from Katakwi, nine (30%) of those from Kumi, three (30%) of those from Kotido, 93 (42.6%) of those from Tororo, four (50%) of those from Mbaale and five (62.5%) of those from Soroti were

<p>| Table 1: Prevalence of Fasciola infection in cattle of different age groups in selected districts in Uganda |
|----------------|-----------------|-----------------|----------------|-----------------|-----------------|----------------|
| District       | ≥6 months       | 6-12 months     | 13-24 months   | &gt;24 months      | Overall         |</p>
<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Prev (%)</th>
<th>n</th>
<th>Prev (%)</th>
<th>n</th>
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<th>n</th>
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<th>n</th>
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</tr>
</thead>
<tbody>
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<td>29</td>
<td>13.8</td>
<td>23</td>
<td>39</td>
<td>108</td>
<td>28.7</td>
<td>167</td>
<td>29.3</td>
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<tr>
<td>Pallisa</td>
<td>22</td>
<td>4.5</td>
<td>36</td>
<td>16.7</td>
<td>40</td>
<td>17.5</td>
<td>84</td>
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<tr>
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<td>19</td>
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<td>29</td>
<td>41.3</td>
<td>27</td>
<td>37</td>
<td>76</td>
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<td>151</td>
<td>45.0</td>
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<tr>
<td>Ntungamo</td>
<td>-</td>
<td>-</td>
<td>22</td>
<td>13.6</td>
<td>40</td>
<td>7.5</td>
<td>88</td>
<td>18.0</td>
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</tr>
<tr>
<td>Total</td>
<td>49</td>
<td>12.5</td>
<td>116</td>
<td>21.6</td>
<td>130</td>
<td>22.3</td>
<td>356</td>
<td>30.3</td>
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<td>26.8</td>
</tr>
</tbody>
</table>
infected with *Fasciola* parasites. All cases had *F. gigantica*.

The number of animals infected with *Fasciola* parasites appeared to gradually increase from February (dry season) and reached the peak in May and June (rainy season) then dropped to the lowest in August (short dry season).

*Other trematode infections*

One (0.6%) animal out of 150 cattle sampled in Masindi had *Schistosoma bovis*.

**Discussion**

This study indicates that *F. gigantica* in cattle is widespread in Uganda and 26.8% of grazing cattle shed *Fasciola* eggs, while 36.8% of the cattle slaughtered carry *Fasciola* parasites. This concurs with earlier findings by Ogambo-Ongom et al. which showed that *F. gigantica* and its intermediate host *Lymnaea natalensis* were distributed throughout Uganda and the regional prevalence of *Fasciola* infection in cattle was related to the number of snail habitats.

The prevalence of *F. gigantica* found in the abattoir study is comparable to 36.5% revealed by similar studies in Tanzania, but it is higher than 11.48% reported in Nigeria and 21% reported in Ethiopia. However, the prevalence of 36.5% found by liver inspection in this study is lower than 54% previously reported in Uganda in similar studies.

This study further revealed that 45% of the cattle examined in Masindi District secreted *Fasciola* eggs. This is in consonance with 46% found previously by Oka in ranch cattle in the same region. But the prevalence of cattle shedding *Fasciola* eggs of 14.6% found in Ntungamo District is lower than 20% found by Sauvage et al. in the same area, then named Ankole District.

The prevalence of *Fasciola* infection in cattle appeared to increase with age. These field
survey results concur with the abattoir results in that abattoir records showed that most of the cattle slaughtered were older than 24 months. Whereas, 30.3% of the grazing cattle older than 24 months secreted Fasciola eggs, 36.8% of the slaughter cattle had Fasciola parasites in the livers. In studies carried out in Kenya, Waruiru et al.\textsuperscript{14} similarly found the prevalence of calves shedding Fasciola eggs higher in older calves than in young ones.

The increase in the number of slaughter cattle detected with Fasciola parasites from the dry season (February) to a peak in May and June (rainy season) then dropped during the short dry season (August) may be explained by seasonal changes in traditional grazing practices in many districts in Uganda which predispose cattle to risk of Fasciola infection. Under traditional grazing management, during the long dry season (December to February) farmers graze cattle mainly in the swampy areas where there is green pasture. Thus many cattle pick metacercariae on pasture near the snail habitats during the dry season. When the rains come much of the grazing is done away from the snail habitats (swampy areas) because there is enough pasture on the common grazing areas hence fewer animals pick metacercariae during the rainy season. Since the life cycle of Fasciola parasites takes about four months, the incidence of fasciolosis is expected to reach its peak in May to June and gradually drop until August.

In other studies carried out in Kenya, a slight increase in the number of animals secreting Fasciola eggs during the rainy season has also been observed\textsuperscript{11}. Similarly, Tegene Negasse\textsuperscript{10} found a higher prevalence of Fasciola infection in cattle during the rainy season (41.47%) than during the dry season (38%) in Ethiopia. This is in agreement with the findings by O gambo-Ongom\textsuperscript{2} in Uganda that infection in snails increased with rainfall, hence by end of the rainy season a high proportion of snails carry cercariae which then changed into metacercariae on pasture surrounding the snail habitats. Hence the risk of transmission of fasciola to cattle is highest during the start of the dry season.

Contrary to the present study, Hyera\textsuperscript{8} found that the prevalence of Fasciola infection in cattle in Tanzania was higher at the start of the dry season and lower at the start of the rainy season. The differences between the seasonal variations in the prevalence of Fasciola infection in cattle observed in Uganda, Kenya and Ethiopia on one hand and Tanzania on the other hand may be due to differences in cattle grazing management during different seasons and differences in type of rainfall received; bimodal versus unimodal.

Abattoir results showed that the prevalence of Fasciola infection in cattle is higher in the high rainfall (with 1,000-1,500 annually) districts of Mbale, Masindi, Bugiri, Busia, Tororo, Pallisa, Kumi and Soroti than in the low to medium rainfall (875-1,000) districts of Moroto, Kotido, Katakwi and Ntungamo. This observation is in line with findings of similar studies conducted in Kenya\textsuperscript{12} and Australia\textsuperscript{13}.

Both F. gigantica and S. bovis were detected in Masindi District, which suggests that both Lymnea natalensis snail, the intermediate host for F. gigantica and Bulinus africanus snail, the intermediate host for S. bovis, exist in this area. However, the prevalence of S. bovis of 0.6% revealed by this study is lower than 2.77% reported in Nigeria\textsuperscript{9} and 14% reported in Ethiopia\textsuperscript{10}.

In conclusion, the prevalence of Fasciola infection of 21.6 to 22% in traditionally managed cattle at a growing age (six - 24 months) and 30.3% at a productive age (over 24 months) is high. There is need for urgent attention in terms of establishing a programme for instituting appropriate control measures to prevent production losses, given that farmers keeping cattle under such management do not currently practise any routine control measures against Fasciola infection.

Acknowledgements

We thank Mr. Philip Jumugishanga and Mr. Joseph Mubuli for the technical assistance during the study. We also thank the District Veterinary Officers of Bugiri, Busia, Masindi,
Mbale, Ntungamo, Pallisa and Tororo for supporting this study. This study received funds partly from DANIDA under the LSRP's project preparatory funds (PPF) and partly from the Agricultural Research Training Programme (ARTP) for the National Agricultural Research Organisation (NARO) for which we are grateful. This paper is published with the permission of the Director of Livestock Health Research Institute (LIRI), Tororo, Uganda.

References

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INTEGRATION OF TSETSE CONTROL WITH FARMING ACTIVITY AMONG CULTIVATORS IN SOUTH-EASTERN UGANDA: A PRELIMINARY REPORT

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INTEGRATION DE LA LUTTE CONTRE LES TSETSE A L'ACTIVITE AGRICOLE CHEZ LES CULTIVATEURS DANS LE SUD-EST DE L'OUGANDA: UN RAPPORT PRELIMINAIRES

Résumé
Ces dernières années, on a mis l'accent sur la participation communautaire à la lutte contre les tsé-tsezé. Le problème principal lié à la participation communautaire à la lutte contre les tsé-tsezé est comment susciter l'intérêt de la communauté après la baisse de la population glossinaire. Toutefois, l'intégration de l'activité économique à la lutte contre les glossines peut susciter l'intérêt puisque l'on en tire un profit direct. Une étude a été menée en utilisant un épouvantail selon la méthode traditionnelle de lutte contre les glossines. Les agriculteurs ont habilité leurs épouvantails avec des jupes bleu - noir en fentes et ils les ont déployés dans leurs jardins. Ces jupes étaient imprégnées de deltaméthrine (Glossinex 200 SC). Des écrans locaux tels que les écrans de toiles à sac, de patchworks et d'arbres étaient également montés, imprégnés et déployés. Cette communication traite de cette méthode de lutte contre les tsé-tsezé par rapport à sa durabilité en associant la communauté et ce, sur la base de l'auto-assistance. Les résultats préliminaires sont présentés.

Abstract
In recent years, emphasis has been put on involving the community in tsetse control. One major problem with community participation in tsetse control is how to maintain community interest after reduction in tsetse population. However, an integration of economic activity with tsetse control can maintain interest since indirect benefit can be seen. A study was carried out to use a scarecrow indigenous knowledge in practice to control tsetse. Farmers dressed their scarecrows with splits of blue-black skirts and deployed them in their gardens. These skirts were impregnated with deltamethrin (Glossinex 200 SC). Local screens such as sackcloth screens, patchwork screens, and tree screens were also made, impregnated and deployed. The paper discusses this approach to tsetse control in relation to its sustainability by involving the community on self-help basis. Preliminary results are presented.

Introduction
Present trends in vector control target cheaper, ecologically acceptable and user-friendly methods, including simple traps and targets impregnated with synthetic pyrethroids. In the last two decades, some success has been reported with the use of impregnated traps to suppress tsetse population in south-eastern Uganda\textsuperscript{1,2}. However, this success has been mainly due to the provision of trap materials and expertise from overseas. This dependency was short-lived. There is, therefore, a need to build sustainability putting emphasis on the use of local materials and community participation\textsuperscript{3,4,5}. In a situation where the vector has become peri-domestic, and transmission cycle in most cases undoubtedly man-fly-man\textsuperscript{4} and where domestic animals, especially cattle and pigs act as reservoirs of the disease, tsetse control by the community on self-help basis seems to be the most appropriate strategy.

There are three major reasons, among others, why community-based programmes fail:

a. Economic and logistical constraints
b. Lack of continued public interest and
c. Lack of voluntary time

To address these constraints one needs: (a) an appropriate low-cost technology and (b) integration of tsetse control with economic activities so that there is both short-term and long-term benefits to the farmer.
The present study investigated the feasibility of involving rice growers in tsetse control using scarecrows and other local targets.

**Materials and Methods**

**Study area**

The study was carried out in the rice growing areas of Kapyanga sub-county, Bugiri District. The area has been described by Okoth.5

**Targets**

**Scarecrow**

In Uganda, farmers often make and use scarecrows to scare away pests, especially monkeys and birds from eating crops such as maize, potatoes, groundnuts and rice in the fields. A survey was carried out to establish which kinds of scarecrows were being used. It was found out that a scarecrow was constructed using sticks tied in a form of a cross and then dressed using banana leaves to give the appearance of a ‘person’. Often these were dressed with old shirts or other appropriate clothing. They were positioned at visible sites at the edge of forests or edges of gardens. The areas around them were cleared for easy visibility; a practice used for setting traps or targets as well. The position of the scarecrows were changed regularly—sometimes twice a day to confuse the pests.

Some scarecrows were made very simple by just hanging a shirt on a stick and allowing sleeves to wave around. Pieces of cloth or plastic materials were also hung by two corners and left flying around to scare away birds in particular. In addition to the scarecrows, tapes of radio cassettes were stretched between poles in the field. These tapes made the sound of a whistle as the wind blew across the field and this re-enforced the usefulness of the scarecrows.

Following the survey, a one-day workshop was held to sensitize the farmers in tsetse control using scarecrows and 50 scarecrows were bought. Each scarecrow was dressed with splits of blue-black skirts, which were impregnated with deltamethrin (Glossinex 200 SC) by the community itself. All the scarecrows were deployed by the individual farmers in different locations.

In order to supplement the efforts of the farmers using scarecrows targets, Local Council’s three Councillors were sensitised to participate in tsetse control. As a result of this activity, Councillors were able to make budgetary provision in their Council budgets for tsetse control. The money obtained was used to purchase blue and black paints to make local screens.

**Sackcloth screen**

Synthetic nylon materials used for making sacks were painted with blue and black oil paints and impregnated with Glossinex 200 SC. These were stronger than lint fabric materials and could withstand harsh weather conditions for long periods of time. Contractor Super Gloss paints manufactured in Nairobi, Kenya by Grand Paints Ltd., were used.

Bioassay tests on these screens had been done previously and the results indicated that they retain residual effects as well as the fabric materials. A sample of the painted sackcloth was sent to the International Centre for Insect Physiology and Ecology (ICIPE) in Nairobi, Kenya for scanning.

An empty sack, at a cost of Uganda shillings 500.00 (US$ .5) made two screens. When the cost of paint and insecticide were added, a sackcloth screen cost Ushs 300.00 (US$. 3). The sackcloth did not have to be new.

Prior to the use of the painted sackcloths as screens, their attractiveness to tsetse fly was tested by comparing with the fabric materials. Three traps were compared namely, painted sackcloth monoscreen trap, lint fabric monoscreen trap and pyramidal trap in a 3x3 Latin Square design experiment. Fabric materials and netting used were all new and from the same material source. The sackcloth monoscreen traps had also been painted recently and were clean. The experiments were carried out between 8.00am. and 4.00 pm each day. Logarithmic transformations (log x + 1) of
trap catches were made before analysis of variance was used to determine the differences in trap catches. Analysis was done using Latin's Version 2.1 (Brightwell, personal communication).

**Patchwork screens**

Patches of blue and black cloths from tailors were collected and stitched together by farmers to make screens. Apart from the exercise being labour-intensive, the cost of the materials themselves was insignificant. The cost of insecticide on each screen was estimated to be Uganda shillings 50.00 (US$ 0.05). The patchwork screens were also impregnated with Glossinex 200 SC and deployed by farmers.

**Tree screens**

Along forest edges fringing swamps, tree trunks of at least 120 cm circumference or more were selected and painted with blue and black oil paints. The trees were painted 15 to 23 cm above the ground and one metre high. The cost of painting and impregnating one tree screen with insecticide was estimated to be US$ 0.30. The community were taught to paint and impregnate the tree screens by themselves. Bushes around the tree screens were cleared for easy visibility by the tse-tse flies.

A bioassay test had been done on these trees and found to be as effective as the lint fabric. Both the sackcloth and patchwork screens were deployed in areas where there were no suitable trees to be painted. Five modified pyramidal traps were provided to some community members to monitor fly population monthly for five days.

**Results**

A total of 187 screens were made: 50 scarecrows, 17 sackcloth screens, 10 patchwork screens and 110 tree screens. The result of scanning the painted sackcloth is shown in Figure 1. The reflectance of the material was fairly comparable with other lint fabrics such as polyester/cotton.

The result of the analysis of variance and detransformed catches of the experiment comparing fabric monoscreen trap, painted sackcloth monoscreen trap and pyramidal trap shows the difference in catches between the traps were highly significant (P<0.01). Assuming fabric monoscreen trap as control, the index of increase was 0.72 times for painted sackcloth and 0.56 times for the pyramidal trap.

Monitoring tsetse population was done from January to May 1997 and preliminary results show that within five months, there was a noticeable decline in fly population; the control had been achieved by 69%.
Table 1. Analysis of Variance and detransformed mean catches of G.f. fuscipes from painted sackcloth monoscreen, lint fabric monoscreen, and pyramidal traps

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Treat. log mean Dtrans mean Index (assuming a = control)

a  1.3702  22.4511  1.00
b  1.1358  12.6721  0.56
c  1.2352  16.1876  0.72

SNK multiple range test on ranked means bc

asterisks indicate pairs of mean are significantly different at the 5% level c*
c**

Key:
df  = Degree of Freedom
SS  = Sums of Square
MS  = Mean Square

Discussion

Tsetsefly control by community using cheaper and economically acceptable methods is becoming increasingly important as priority is now shifting to other diseases such as malaria, schistosomiasis and onchocerciasis. To prevent the dramatic and costly sleeping sickness epidemic of the 1980s, public health and control of sleeping sickness in Uganda must continue to be given priority consideration. The communities should be empowered and facilitated so that they assume responsibility and accountability for vector control on self-help basis.

The use of scarecrows as targets for tsetse fly control is an innovative idea as integrating tsetse fly control with farming activities. The scarecrow idea is an indigenous knowledge already in practice. They were dressed with strips of blue and black materials similar to the strips used by Lancien on his monoscreen trap. However, this trap unlike scarecrow, is expensive, requires hard plastic and equipment for making.

A painted sackcloth enough for a screen cost Ushs. 300.00 (US$ 0.3) as compared to lint fabric screen which cost Ushs. 2,000.00 (US$ 2.0). The World Health Organization estimated the cost of vector control using impregnated screens to be US$ 2-4 per head of population when each screen costs US$ 4-8. These costs include related overheads. In this study, sackcloth cost US$ 0.3 but it was put to US$ 0.5 to include overhead costs. At this rate, the cost of control can be estimated to be US$ 0.25 per head of population. This is one-eighth of the WHO estimate. In the case of patchwork and tree screens, the cost of control could be much lower than this estimate since the materials themselves cost nothing except for insecticide in the case of patchwork screen and paint and insecticide in the case of tree screen.

More research is necessary to evaluate the use of tree screens in the control of Glossina fuscipes fuscipes in south-eastern Uganda. Since paint seems to work fairly well for traps and targets, and the latter when impregnated with insecticide can reduce tsetse fly population quite considerably, more research is required on the use of other locally available materials such as papyrus and banana fibre mats. The present study shows for the first time in Uganda and probably elsewhere that it is possible to integrate farming activity with tsetse control.

Acknowledgements

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References


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Donkeys are known to harbour a wide variety of gastrointestinal helminths. Although the epidemiological aspects of some important worms in most domestic animals have been studied, the situation in donkeys is rather different. To facilitate formulation and implementation of strategic control measures of donkey internal parasites, there is a need to study the epidemiology of such parasites in donkeys. The purpose of this study was to investigate the influence of season and age on the occurrence of gastrointestinal helminths in donkeys in Kiambu District of Kenya.

The study was conducted over a one year period (August, 1994 to August, 1995) in various parts of Kiambu District where 331 donkeys were examined for gastrointestinal helminth infestations by means of faecal egg counts. The climatic data for the area during the study period were obtained from Kiriita Forest Meteorological Station. The sex and age of each donkey were recorded. To estimate the age of each donkey, the method described by Donald and Tutt was used. On this basis, the donkeys were classified as either young (<4 years), medium aged (4-8 years) or adults (>8 years).

Nematode eggs in faecal samples were enumerated using the modified McMaster egg counting technique, and the number expressed as eggs per gram (EPG) of faeces. The mean monthly counts were calculated for each donkey and was recorded. The mean egg counts were compared either among sexes, ages or seasons using the student’s t-test.

The climate of the study area was characterized by a short rainy period (September to November, 1994), a short dry period (December and January, 1995), a long rainy period (February and March, 1995) and a long dry period (June to August, 1995), as illustrated in Figure 1 below.

Figure 1: The trend of mean strongyle EPG counts in relation to rainfall in donkeys in Kiambu District (August, 1994 – August, 1995)

Of the 331 donkeys examined, 280 (85%) were infected. Out of the 236 male and 93 female donkeys examined, 202 (85%) and 78 (84%) were positive for gastrointestinal helminths, respectively. When age was put into consideration, the infestation rates were as follows: young donkeys, 40 out of 42 (95%); medium-aged donkeys 62 out of 80 (78%) and adult donkeys 195 out of 231 (84%). As regards the seasons, the infestation rates were as follows; short rainy season, 84%; short dry season, 66%, long rainy season 98% and long dry season 66%.

The mean strongyle egg counts showed an increase during the short rainy season (mean = 1,273 ± 71 EPG) and a decrease during the
short dry season (mean = 882 ± 54 EPG). Another increase was noted during the long rainy season (mean = 1,177±203 EPG) followed by a decrease during the long dry period with a mean EPG of 519 ± 86 (Fig. 1). The mean egg counts were significantly higher (p<0.05) during the short dry season compared to the long dry season. There was no significant difference in egg counts between the short rainy season and long rainy season.

On average, the male donkeys had significantly higher (p<0.05) counts (mean = 996±415 EPG) compared to the female donkeys (mean = 763 ± 471 EPG). As regards age, the young donkeys had significantly higher egg counts (mean = 1,469 ± 622 EPG) than either the medium-aged (mean = 544 ± 347 EPG) or the adult donkeys (mean = 988 ± 454 EPG) and the adult donkeys had higher counts than the medium aged donkeys.

In the present study, the infestation rate of donkeys with gastrointestinal helminths (on the basis of faecal egg counts) was found to be quite high (85%). There was no difference in the infestation rates between male and female donkeys. However, there was a higher infestation rate in the young donkeys compared to both the medium aged and adult donkeys. This was also reflected in the level of infection, where the young donkeys had higher egg counts. This phenomenon can be attributed to the fact that the more mature the animal, the more resistant it becomes to helminth infection.\(^5^,\(^7^\)

Egg counts in the donkeys were higher during the rainy seasons than in the dry seasons. The increase in egg counts started at the beginning of the rains and peaked towards the end of the rains. Like in the observations made by other authors,\(^8^\) the increase can be attributed to the increase in the number of worms and accumulation of adult strongyles. This is primarily from newly acquired larvae, which accumulate on pasture during the wet periods. Furthermore, the occurrence of most adult strongyles towards the end of the dry season brings about heavy pasture contamination at the beginning of the wet season, particularly because this coincides with the peak egg output.\(^8^\)

Climatic factors and age of host had a significant influence on the prevalence and levels of infection with helminths in the donkeys. These factors should be considered in the design and of any strategic or integrated control strategies.

Acknowledgments

The authors wish to thank the Director of Veterinary Services (DVS), the Chief Veterinary Investigation Officer (CVIO) and the Assistant DVS, Kenya, the Central Veterinary Laboratories, Kenya for their assistance when carrying out this study. A vote of thanks is also extended to staff of the Department of Veterinary Pathology and Microbiology, University of Nairobi for their assistance. This project was funded by the Dean’s Committee, University of Nairobi and the DANIDA-funded Ruminant Helminth Research Project at the University of Nairobi through the Royal Danish Embassy, Nairobi.

References


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OBSERVATIONS ON THE EFFECT OF TWO DIFFERENT ANTHELMINTICS ON THREE DIFFERENT REGIMENS ON LOCAL LAMBS

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¹Department of Veterinary Medicine, and ²Department of Veterinary Public Health and Preventive Medicine, University of Ibadan, Nigeria.

REMARQUES SUR L'EFFET DE DEUX DIFFERENTS ANTHELMINTHIQUES SUR TROIS DIFFERENTS REGIMES DE TRAITEMENTS CHEZ LES AGNEAUX LOCAUX

Résumé
Soixante-cinq agneaux nains de l'Afrique de l'ouest âgés de 16 semaines au sevrage abrités dans une ferme de projet laitier urbain à Ibadan au Nigeria étaient diagnostiqués comme souffrant d'helmintase. Trois groupes étaient traités avec: l'albendazole par voie orale, le phosphate de levamisole par injection et une association de ces deux anthelmintiques. Chaque groupe a reçu de nouveau trois régimes de traitement stratégique, tactique et conventionnel, soit un total de 4,6 et 6 traitements annuels en série à divers intervalles respectivement.

L'anthelmintique à large spectre de l'albendazole par voie orale en plus de la double action de l'anthelmintique de levamisole par injection ont accru l'efficacité anthelmintique de leur association comme le montraient la baisse très forte (94,4%) du nombre d'œufs et le gain moyen quotidien très élevé de 0,0343 kg par agneau. Le régime de traitement adopté pour les médicaments combinés ont également contribué à leur excellente efficacité puisque 5 des 6 traitements se sont succédés de très près au pic des mois pluvieux de l'année. La dépendance du régime de traitement stratégique par rapport aux précipitations et la dépendance du régime de traitement tactique par rapport au nombre d'œufs ont réduit l'efficacité des anthelmintiques respectifs en termes de réduction des œufs de ver et de taux de croissance de l'agneau.

L'utilisation plus fréquente de la combinaison des deux anthelmintiques qui pourrait constituer une contrainte financière était compensée par le gain notable de poids vif des agneaux.

Abstract
Sixty five 16-week-old weaner West African dwarf lambs housed at the Urban Dairy Project Farm, Ibadan, Nigeria were diagnosed of helmintosis. Treatment was instituted in three groups with oral albendazole, injectable levamisole phosphate and a time-variable alternatives of these two anthelmintics. Each group again, had three treatment regimens of strategic, tactical and conventional totalling 4, 6, and 6 annual serial treatments at varied time intervals, respectively.

The broad anthelmintic spectrum of oral albendazole plus the double anthelmintic mode of actions of the injectable levamisole enhanced the anthelmintic efficacies of their combination as evidenced by their highest (94.4) percentage reduction in egg counts and highest mean daily weight gain of 0.0343 Kg per lamb. The conventional regimen adopted for the combined medicaments also contributed to its excellence as 5 of the 6 serial treatments came in dose succession at the peak of the rainy months of the year. The rainfall pattern-dependence of the strategic regimen and the egg-count dependence of the tactical regimen reduced the efficacies of the respective anthelmintics in terms of worm egg reduction and lamb's growth rate. The more frequent use of the combination formula which could constitute financial constraint on its adoption was compensated for by the substantial live weight gains of the lambs.

Introduction
Trychostrongylidosis constitutes a major constraint to small ruminant production in southern Nigeria where the longer rainy season enables an all-year round survival of parasitic stages of the nematodes¹. In a nation-wide survey, Schillhorn Van Veen et al², and Eysker and Ogunsusi³ identified Haemonchus contortus, H. placei and other tropical trichostrongylids in the small and large ruminants as being responsible, in part, for the severe anaemia, diarrhoea, reduced weight gain, inappetence, hypoalbuminaemia, reduced plasma pepsinogen, general unthriftiness and death in these stocks.
The most pathogenic members include *H. contortus* and *Trichostrongylus axei* in small ruminants. Unfortunately, *H. contortus* was reported to develop resistance to some benzimidazoles in Australia and Latin America. This resistance was attributed to the habitual use of a few cheap anthelmintics or indiscriminate regimens by farmers. It was with this background that this study was done to identify the most effective anthelmintic preparations and regimens that would reduce the effects of trichostrongyloid infections and improve the growth rate of lambs on the farm.

**Materials and Methods**

*Clinical observations on the flock before trial*

The sixty five weaner lambs of about 16 weeks of age housed at the government owned Urban Dairy Project Farm, Iwo road in Ibadan were used for this study. Most (80%) of the weaner lambs were weak and fragile with some pale visible mucosae while the remaining were vigorous and alert. Again, 65% of the flock had inappetence, transient brownish diarrhoea, dehydration, starry hair coat, fetid mouth odour and normal to subnormal rectal temperatures. Emaciation was evident by prominent ribs and unsteady gaits. Helminthosis was suspected as we had suspended the routine two-monthly deworming exercise for three months in anticipation of this trial.

The lambs were randomly divided into three age-and sex-matched groups A, B, and C, of 22, 21 and 22 lambs respectively. Each group was again sub-divided into three viz A1, A2, A3, B1, B2, B3, C1, C2, and C3, with the subgroups again arranged according to their deworming regimen viz A1, B1, and C, on prophylactic strategic; A2, B2, and C2, on curative tactical, and A3, B3, and C3 on the conventional (every-other-month) deworming regimen that had long been practiced on the farm.

**Management of the experimental animals**

The nine groups of lambs were housed separately in concrete-floored pens that were provided with wood shavings as litters. Pens were separated by green tropical pasture dominated by the carpet grass (*Axonopus compressus*), guinea grass (*Panicum maximum*) and elephant grass (*Pennisetum purpureum*). Pasture feeds were regularly supplemented with brewers grains and dry peelings of cassava (*Manihot esculata*). Water was provided *ad libitum* to all the groups.

Dipping was done monthly with 1% Coumaphos solution (Asunto!-Bayer, Germany) in large plastic baths. Lambs were vaccinated against *Pestes des petits ruminants* (PPR) viral infection, by the use of the Tissue Culture Rinderpest Vaccine (TCRV) supplied by the National Veterinary Research Institute, Vom, Nigeria.

**Helminthological screening**

Prior to the commencement of the treatments and on a two-weekly routine, faecal egg counts for three randomly selected lambs in each subgroup were done using the modified McMasters' egg counting method, using the saturated NaCl solutions for the nematodes and cestodes and ZnSO4 solution for the trematodes. Based on the percentage mean relative egg counts per 3.0gms of the bulked faecal sample, the percentage infection rates for the strongylate worms (nematodes), *Moniezia* spp (cestodes) and flukes (trematodes) were estimated as described by Keith, (Table 1).

<table>
<thead>
<tr>
<th>Helminth type</th>
<th>Strongylate species of helminths</th>
<th>Fasciola species</th>
<th>Moniezia species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean faecal egg counts per gram</td>
<td>5,037 ± 452</td>
<td>97 ± 14</td>
<td>118 ± 32</td>
</tr>
<tr>
<td>% infection estimate</td>
<td>95.9</td>
<td>1.8</td>
<td>2.3</td>
</tr>
</tbody>
</table>

**Deworming regimens**

Optimal dosing time of the year for the strategic regimen sub-groups was guided in this trial by the previous relative faecal egg counts changes and the rainfall distribution pattern for the 1981-82 farming year as reported by Bobade et. al.
(Fig. 1). Thus, sub-groups A', B, and C', had their respective anthelmintic treatments on a prophylactic strategic regimen on four quarterly basis in August, December, March and June with B, on albendazole in August and March and on levamisole in December and June. Similarly, sub-groups A, B, and C, had their treatments on a curative tactical basis in January, March, May, July, September and November with B, on albendazole in March, July and November and on levamisole in January, May and September. The sub-groups A, B, and C, had their treatments on a conventional basis in April, June, August, October, December and February with B, on levamisole in August, December and April and on levamisole in June, October, December and February with B, on albendazole in August, December and April and on levamisole in June, October and February.

**Determination of group mean live weight gain and mean daily live weight gain**

The sixty five lambs were weighed at the beginning of the experiment and at every month end to determine their growth rate as routinely required. Thorough randomization was employed for the grouping of lambs to eliminate possible parental traits influences.

**Statistical analysis**

Data collected on egg counts, percentage egg reduction, weight gains, etc, were subjected to statistical analysis using the student 't' test for the comparison of the two means of paired sub-group values. Differences were considered statistically significant at the 5% level.

**Results**

Mean faecal egg counts and the corresponding percentage infection rate estimates for the 65 lambs at the start of the experiment are shown in Table 1. The strongylate nematodes had highest toll of 95.9%, the *Moniezia* species of cestodes 2.3% and the *Fasciola* species of trematodes 1.8%. Clinical signs associated with this nematode-dominated mixed infection included severe anaemia, inappetence, diarrhoea, rough hair coat and most importantly emaciation.

**Table 1. Percentage estimate of helminth infection and their corresponding mean faecal egg counts in weaner lambs before treatment**

<table>
<thead>
<tr>
<th>Helminth type</th>
<th>Strongylate species of helminths</th>
<th>Fasciola species</th>
<th>Moniezia species</th>
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</thead>
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<td>118 ± 32</td>
</tr>
<tr>
<td>% infection estimate</td>
<td>95.9</td>
<td>1.8</td>
<td>2.3</td>
</tr>
</tbody>
</table>

The quarterly group mean of strongylate egg counts (of 95.9% infection rate) and their annual percentage reduction under the three medications and regimens are as shown in Table 2, while the group mean and individual mean daily live weight gains for all treatments and regimens are as shown in Table 3.
### Table 2: Quarterly group mean egg variations for gastrointestinal helminths under three medications and regimens

<table>
<thead>
<tr>
<th>Group</th>
<th>Dewormer</th>
<th>Sub-group &amp; Regimen</th>
<th>Quarterly means of egg counts per gram</th>
<th>Reduction in egg count %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1st Quarter</td>
<td>2nd Quarter</td>
</tr>
<tr>
<td>A</td>
<td>Albendazole suspension (Valbazen® - SK)</td>
<td>A₁ Strategic (S)</td>
<td>4,084 ± 1,100</td>
<td>3,554 ± 744</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A₂ Tactical (T)</td>
<td>4,517 ± 872</td>
<td>3,242 ± 484</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A₃ Conventional (C)</td>
<td>4,705 ± 1,005</td>
<td>3,182 ± 748</td>
</tr>
<tr>
<td>B</td>
<td>Albendazole suspension and levamisole injectable (Nilverm® - ICI)</td>
<td>B₁ - (S)</td>
<td>5,123 ± 1,230</td>
<td>2,185 ± 254</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B₂ - (T)</td>
<td>4,870 ± 834</td>
<td>2,465 ± 360</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B₃ - (C)</td>
<td>5,002 ± 1,025</td>
<td>1,093 ± 59</td>
</tr>
<tr>
<td>C</td>
<td>Levamisole injectable</td>
<td>C₁ - (S)</td>
<td>4,855 ± 865</td>
<td>3,652 ± 425</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C₂ - (T)</td>
<td>4,760 ± 1,055</td>
<td>2,005 ± 275</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C₃ - (C)</td>
<td>5,246 ± 1,712</td>
<td>2,553 ± 454</td>
</tr>
</tbody>
</table>

Data are expressed as Mean ± Standard Deviation.

### Table 3: Group mean and individual live weight changes for the two anthelmintic treatments on three regimens

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sub-groups &amp; number of lambs</th>
<th>Treatment regimens</th>
<th>Number of treatments</th>
<th>Live weight changes in 12 months in Kgs.</th>
<th>Group mean live weight in Kgs.</th>
<th>Group mean live weight gain</th>
<th>% group mean live weight gain</th>
<th>Mean live weight gain/day/lamb</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Start</td>
<td>End</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Albendazole suspension (Valbazen® - SK)</td>
<td>A₁ - 7</td>
<td>Strategic (S)</td>
<td>4</td>
<td>36.41</td>
<td>88.72</td>
<td>52.31</td>
<td>143.70</td>
<td>0.0205</td>
</tr>
<tr>
<td></td>
<td>A₂ - 8</td>
<td>Tactical (T)</td>
<td>6</td>
<td>40.02</td>
<td>102.15</td>
<td>62.13</td>
<td>155.25</td>
<td>0.0213</td>
</tr>
<tr>
<td></td>
<td>A₃ - 7</td>
<td>Conventional (C)</td>
<td>6</td>
<td>36.82</td>
<td>104.06</td>
<td>67.24</td>
<td>182.60</td>
<td>0.0263</td>
</tr>
<tr>
<td>Albendazole suspension plus Levamisole phosphate injectable (Nilverm® - ICI)</td>
<td>B₁ - 6</td>
<td>(S)</td>
<td>4</td>
<td>32.21</td>
<td>105.73</td>
<td>70.52</td>
<td>172.40</td>
<td>0.0258</td>
</tr>
<tr>
<td></td>
<td>B₂ - 7</td>
<td>(T)</td>
<td>6</td>
<td>35.61</td>
<td>125.42</td>
<td>85.81</td>
<td>217.30</td>
<td>0.0301</td>
</tr>
<tr>
<td></td>
<td>B₃ - 8</td>
<td>(C)</td>
<td>6</td>
<td>39.82</td>
<td>140.16</td>
<td>100.34</td>
<td>252.00</td>
<td>0.0343</td>
</tr>
<tr>
<td>Levamisole phosphate injectable (Nilverm® - ICI)</td>
<td>C₁ - 7</td>
<td>(S)</td>
<td>4</td>
<td>36.23</td>
<td>90.35</td>
<td>54.12</td>
<td>149.40</td>
<td>0.0212</td>
</tr>
<tr>
<td></td>
<td>C₂ - 8</td>
<td>(T)</td>
<td>6</td>
<td>39.60</td>
<td>104.16</td>
<td>65.00</td>
<td>164.14</td>
<td>0.0223</td>
</tr>
<tr>
<td></td>
<td>C₃ - 7</td>
<td>(C)</td>
<td>6</td>
<td>37.52</td>
<td>107.31</td>
<td>69.79</td>
<td>186.00</td>
<td>0.0273</td>
</tr>
</tbody>
</table>
A positive correlation was observed between the percentage reduction in egg counts and the group mean annual and/or individual daily live weight gains of the different lamb sub-groups with sub-group B\textsubscript{3} as the highest and sub-group A\textsubscript{1}, the lowest of the nine.

Using the percentage reduction in egg counts to compare statistically the anthelmintic efficacies of paired sub-groups, thus:

For strategic regimen, A\textsubscript{1}/B\textsubscript{1} had \( P < 0.01 \), C\textsubscript{1}/B\textsubscript{1} had \( P < 0.01 \) and A\textsubscript{1}/C\textsubscript{1} had \( P > 0.05 \).

For tactical regimen, A\textsubscript{2}/B\textsubscript{2} had \( P < 0.05 \), C\textsubscript{2}/B\textsubscript{2} had \( P < 0.01 \) and A\textsubscript{2}/C\textsubscript{2} had \( P > 0.05 \).

For conventional regimen, A\textsubscript{3}/B\textsubscript{3} had \( P < 0.05 \), C\textsubscript{3}/B\textsubscript{3} had \( P < 0.05 \) and A\textsubscript{3}/C\textsubscript{3} had \( P > 0.05 \).

Also the percentage reduction in egg counts was used to statistically compare the effectiveness of anthelmintics used for paired sub-groups, thus:

Oral albendazole only - A\textsubscript{1}/A\textsubscript{2} had \( P > 0.05 \), A\textsubscript{1}/A\textsubscript{3} had \( P > 0.05 \) and A\textsubscript{1}/A\textsubscript{3} had \( P < 0.05 \).

Oral albendazole plus

Injectable levamisole - B\textsubscript{1}/B\textsubscript{2} had \( P < 0.05 \), B\textsubscript{1}/B\textsubscript{3} had \( P < 0.05 \) and B\textsubscript{1}/B\textsubscript{3} had \( P < 0.001 \).

Injectable levamisole only, C\textsubscript{1}/C\textsubscript{2} had \( P < 0.05 \), C\textsubscript{1}/C\textsubscript{2} had \( P < 0.05 \) and C\textsubscript{1}/C\textsubscript{2} had \( P < 0.05 \).

Similarly, the group mean annual and/or individual mean daily live weight gains were used as bases for the statistical comparison of efficacies of regimen adopted for paired sub-groups, thus:

For strategic regimen, A\textsubscript{1}/B\textsubscript{1} had \( P < 0.001 \), C\textsubscript{1}/B\textsubscript{1} had \( P < 0.001 \) and A\textsubscript{1}/C\textsubscript{1} had \( P > 0.05 \).

For tactical regimen, A\textsubscript{2}/B\textsubscript{2} had \( P < 0.001 \), C\textsubscript{2}/B\textsubscript{2} had \( P < 0.001 \) and A\textsubscript{2}/C\textsubscript{2} had \( P < 0.05 \).

For conventional regimen, A\textsubscript{3}/B\textsubscript{3} had \( P < 0.001 \), C\textsubscript{3}/B\textsubscript{3} had \( P < 0.001 \) and A\textsubscript{3}/C\textsubscript{3} had \( P > 0.05 \).

Also the individual mean daily live weight gains were used to compare the effectiveness of the anthelmintics used in paired sub-groups, thus:

Oral albendazole only - A\textsubscript{1}/A\textsubscript{2} had \( P < 0.01 \), A\textsubscript{1}/A\textsubscript{3} had \( P < 0.05 \) and A\textsubscript{1}/A\textsubscript{3} had \( P < 0.001 \).

Oral albendazole plus

Injectable levamisole - B\textsubscript{1}/B\textsubscript{2} had \( P < 0.05 \), B\textsubscript{1}/B\textsubscript{3} had \( P < 0.05 \) and B\textsubscript{1}/B\textsubscript{3} had \( P < 0.05 \).

Injectable levamisole only, C\textsubscript{1}/C\textsubscript{2} had \( P < 0.05 \), C\textsubscript{1}/C\textsubscript{2} had \( P < 0.05 \) and C\textsubscript{1}/C\textsubscript{2} had \( P < 0.01 \).

Three lambs (two from group B and one from group C) died of pathologically confirmed bacterial pneumonia before the end of the 12-month study and the group mean live weights were adjusted accordingly.

**Discussion**

The high prevalence of trichostrongylid nematode infection in the flock was not only predictable from the age and climatic predispositional factors\textsuperscript{13} but also corroborated earlier reports\textsuperscript{1,4,14,15,16,17} on the situation in the south-eastern and western zones of Nigeria.

Some of the clinical manifestations of trichostrongylidosis in the flock like diarrhoea, dehydration, anaemia, emaciation, general unthriftness and death are of economic interest to the producer, not only in terms of direct loss of animals and poor growth rate, but also in terms of resources expended on treatment and control. Okon and Enyenih\textsuperscript{4} and Fagbemi and Dipeolu\textsuperscript{5} had earlier incriminated *Haemonchus contortus*, *Trichostrongylus spp.*, *Coopera spp.*, *Strongyloides spp.*, *Gaigeria spp.* and a few other members of the Trichostrongylidae family of nematodes for such economically-draining affliction of sheep in the south-western zone of Nigeria. However, the observation of a positive correlation between the percentage reduction in egg counts and the live weight gains in lambs following different anthelmintic treatment provided proof of the general effectiveness of this chemotherapeutic method of control.
The treatment combination formula of oral albendazole and injectable levamisole phosphate on time-alternating conventional regimen provided the best treatment for the infection in terms of both the percentage reduction in egg counts and the daily live weight gains of the lambs. Conversely, the oral albendazole therapy on strategic regimen was the least effective of the three treatments and regimens in terms of the same parameters as above. The excellence of the alternating albendazole-levamisole treatment formula might not be unconnected with the inherent safety, high efficacy and broad anthelmintic spectrum of the benzimidazole series of anthelmintics to which albendazole belongs. Albendazole, like all members of the benzimidazole series of anthelmintics hinges its anthelmintic mode of action on the inhibition of the fumarate reductase enzymatic action that furnishes energy for the worms survival in the gut. Levamisole, like the albendazole employs the same fumarate reductase enzymatic inhibition mode of action, and also the ganglionic stimulation that results in rapid and sustained contraction of nematode muscle with spastic paralysis and ultimate expulsion as another. However, this double mode of action of levamisole is restricted to the nematodes unlike albendazole that acts on the nematodes, cestodes and trematodes. It is probable that the double mode of action of levamisole assisted the albendazole-levamisole alternating treatment formula in combatting the possible benzimidazole-resistant strains of *H. contortus* earlier observed. Again, while the narrower anthelmintic action of levamisole might be held responsible for the lower daily live weight gains of the group C lambs, its more sophisticated mode of action gives it an edge over albendazole on resistant helminths and makes it an excellent pair with the benzimidazoles in preventing resistance.

The conventional regimen adopted for the sub-groups B, C, and A, also enhanced the respective efficacies of the anthelmintic employed as evident from the positive correlation between the percentage reduction in egg counts and live weight gains especially in the sub-group B. Climatic factors, especially the rainfall pattern are the basis of formulation for the strategic programme, since this relates to the availability of infective larvae.

Unfortunately, the rainfall pattern changes over a period of years at any given place. Such unanticipated changes in the yearly rainfall pattern might be responsible for the lower performance of the strategic regimen in terms of reducing pasture contamination by optimal treatment time-intervals. The tactical regimen on the other hand, is a curative approach dictated by faecal egg output which again is influenced by the immunity status of the hosts, species of helminths, consistency of faeces, stage of maturity of worms, and the occurrences of parturient egg rise. Wrong timing of these regimens as influenced by these variables might be responsible for their lower performance compared to the conventional regimen.

On the superior performance of sub-group B over B, the six treatments of B were at closer alternating intervals with five of the treatments between the months of March and October; the peak of the rains for 1982 (Fig. 1) while B had longer intervals with only four treatments at these peak months as guided by the pre-1982 rainfall pattern on the farm (Fig. 1). In summary, helminth control in the sub-group B was much enhanced by its synchronization with the rainfall pattern as recommended.

Two important economic issues relate with the most effective control medication and regimens in this study, one is cost-arising from the combination and frequency of use, while the other is that of toxicity of levamisole already reported. A compromise recommendation is to diligently pursue the conventional treatment regimen so that the total live weight gain compensates for the additional cost of drugs. Levamisole toxicity has been successfully averted by a further dilution process with the distilled water or normal saline of the calculated dose volume and two or three serial subcutaneous injections at three-hourly intervals in most farm stocks.
Acknowledgement

We are grateful to the staff of the Ministry of Agriculture and Natural Resources, Ibadan, Oyo State; who served at the Urban Dairy Project Farm from 1980 to 1984 for their cooperation and assistance. We are also indebted to the staff of the State Diagnostic Laboratory, Mokola, Ibadan for their technical assistance.

References


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PREVALENCE ET IMPORTANCE ECONOMIQUE DE FASCIOLE ET D’AUTRES
HELMINTHES DES BOVINS ET DES OVINS DANS LE DISTRICT DE NYANDARUA AU
KENYA

Résumé
On a noté tous les jours pendant une année les informations sur les maladies parasitaires et les autres maladies provoquant la condamnation totale ou partielle des carcasses de bovins et de moutons dans 30 abattoirs du district de Nyandarua dans le centre du Kenya. Au total, 5259 bovins et 5967 moutons étaient abattus pendant cette période, soit environ 58% de tous les bovins et moutons abattus dans tout le district. Parmi tous les bovins abattus, seules 3 carcasses (0,06%) étaient entièrement condamnées à cause de la péritonite septique. La condamnation annuelle des organes chez les bovins due aux helminthes était de 19% de l’ensemble des bovins abattus. Les vers parasites responsables de la condamnation était Fasciola (douves du foie) 15,5%, Oesophagostomum (intestin pustuleux) 2%, Paramphistomum (douves de l’estomac) 1,2% et Cysticercus bovis (cysticerque) 0,04%. Le nombre le plus élevé de foies condamnés chez les bovins à cause des douves du foie était constaté en octobre et en février pendant la saison sèche. Il n’y avait pas de saison précise pour ce qui est du nombre des autres organes condamnés à cause des autres parasites. Chez les moutons, le taux annuel de la condamnation d’organes était de 42,4% de tous les animaux abattus réparti comme suit: condamnation due à Fasciola (35,4%), Stilesia hepatica (5,3%), Oesophagostomum (1,2%) et Cysticercus tenuicollis (0,5%). Le nombre le plus élevé de foies condamnés dus aux douves du foie chez les moutons a été relevé en septembre, octobre et février pendant la saison sèche. La perte annuelle de production bovine et ovine était évaluée à environ 7.080 $ EU et 15.550 $ EU respectivement, suite à la condamnation des organes due à l’infection par les helminthes. La cause de la plus part des pertes était l’infection par Fasciola chez les bovins (83%) et les moutons (84%) et par Stilesia hepatica (13%) chez les moutons; ces pertes n’incluent pas les pertes de production dues: à la baisse de la production de lait, de laine et de viande; à la sensibilité accrue aux maladies; aux coûts du traitement et aux mortalités provoquées par la distomatose. Il est recommandé d’intensifier la lutte contre Fasciola pour réduire ces pertes.

Abstract
Information on parasitic and other conditions causing whole or part condemnation of cattle and sheep carcasses was recorded daily for a period of one year from 30 slaughter slabs in Nyandarua District in central Kenya. A total of 5,259 cattle and 5,967 sheep were slaughtered in the slabs during that period. This represented approximately 58% of all cattle and sheep slaughtered in the entire district. Only three cattle (0.06%) carcasses out of the total killed were condemned entirely due to septic peritonitis. The annual condemnation for organs in cattle due to helminth parasites was 19% of the total kill. The causes of condemnation were Fasciola (liver flukes) 15.5%, Oesophagostomum (pimplly gut) 2%, Paramphistomum (stomach flukes) 1.2% and Cysticercus bovis (beef measles) 0.04%. The highest number of livers condemned in cattle due to liver flukes was in October and February during the dry season. There was no seasonality in the number of other organs condemned due to the other parasites. In sheep, the annual rate of organ condemnation was 42.4% of the total kill. This was due to Fasciola 35.4%, Stilesia hepatica 5.3%, Oesophagostomum 1.2% and Cysticercus tenuicollis 0.5%. The highest number of livers condemned due to liver flukes in sheep was in September, October and February in the dry season. The annual loss was estimated at approximately US $ 7,080 and US $ 15,550 in cattle and sheep production respectively, as a result of condemnation of organs due to helminthic infections. Most of the losses were due to Fasciola in cattle (83%) and in sheep (84%), and Stilesia hepatica (13%) in sheep. This does not include production losses due to reduced milk, wool and meat production, increased susceptibility to disease, costs of treatment and mortalities due to fascioliasis. Intensification of control strategies for Fasciola is recommended to reduce these losses.
Introduction

Helminth infections in ruminants are of considerable economic importance in Kenya. These infections not only cause clinical disease and mortalities but also production losses through reduced weight gain, milk and wool production, increased susceptibility to other diseases and condemnation of the whole carcass or specific organs at slaughter.

In Kenya, it has been reported that the Kenya Meat Commission (KMC) lost Kshs. 800,000 (approximately US$ 11,000) for the period 1954 to 1966 from liver condemnation due to fasciolosis. A later survey gave an estimated annual loss of Kshs. 332,000 (approximately US$ 4500) from KMC through condemnation due to fasciolosis for the period 1975 to 1978. In 1986, annual losses due to liver fluke infection in cattle, sheep and goats in the whole country were estimated at Kshs. 326 million (approximately US$ 4.7 million). Other documented major causes of organ condemnation in ruminants in Kenya are hydatidosis, Cysticercus bovis infection and Stilesia hepatica.

Nyandarua District, a medium to high rainfall region (mean annual rainfall ranges from 1,000 to 2,000 mm) in the central highlands of Kenya, has been classified as a high prevalence area (>40%) for Fasciola in ruminants. The majority of farmers in the district keep exotic breeds of cattle for meat and milk and sheep for wool and meat. Heavy mortalities due to acute fasciolosis have been reported in sheep in the area but the total economic losses due to such infections have not been determined. Economic losses due to Fasciola and other helminth parasites in cattle and sheep as a result of condemnation of whole carcasses or specific organs at slaughter in the district have also not previously been determined.

This paper provides information from a survey carried out in slaughter slabs in the district to assess the economic losses due to these parasites in cattle and sheep at slaughter.

Materials and Methods

The data presented in this study was collected for a period of 12 months from June 1994 to May 1995 from 30 slaughter slabs distributed over all five divisions (Ol-Kalau, Ol-Joro-Orok, Kipipiri, Ndaragwa and Kinangop) of Nyandarua District. Animal Health Officers (AHO) conducting meat inspection in the various slaughter slabs were requested to record daily information on slaughter and condemnation of cattle and sheep carcasses on a data sheet designed by the authors. The AHO were requested to give the name of the slaughter slab, the division in which it is located, date of slaughter, species of animal, origin of animal, breed, sex, age, total number of animals slaughtered during the day, estimated monetary value of condemned carcasses or organs and reason for condemnation. Data for cattle was recorded separately from that of sheep. Information on the total number of cattle and sheep slaughtered in the entire district during the study period was obtained from records at the Ministry of Agriculture, Livestock Development and Marketing. The data recorded was analysed monthly.

Results

During the period of study, a total of 5,259 cattle and 5,967 sheep were slaughtered in the 30 slaughter slabs. All the animals slaughtered were from within the district and represented approximately 58% of all cattle and sheep slaughtered in the entire district during that period.

The percentage occurrence of various helminth infections and other conditions in cattle carcasses and the economic losses as a result of condemnation are given in Table 1. Out of the total number of cattle slaughtered, three were condemned entirely due to septic peritonitis. The main organs condemned were livers due to liver fluke (Fasciola) infection, which accounted for 15.5% of the total number of cattle slaughtered and 82.5% of all parasitic conditions encountered, intestines due to pimply gut (2% of total kill and 10.6% of parasitic conditions) and stomachs due to stomach flukes (1.2% of total kill and 6.4% of the parasitic conditions). Two carcasses were condemned entirely due to Cysticercus bovis. The total economic loss due to the parasitic conditions was estimated at
approximately US$ 7,680. Eighty five per cent (85%) (approximately US$ 6,520) of which was due to condemnation of livers because of Fasciola.

In Table 2 below, the percentage of various helminth infections in sheep carcasses and the economic losses as a result of organ condemnation are given. The total number of sheep which had their organs condemned were 2,530 (42.4% of total kill). The organs were condemned due to liver fluke infection, which comprised 83.5% of all the parasitic conditions and 35.4% of the total kill, *Stilesia hepatica* (12.5% of the parasitic conditions and 5.3% of the total kill), pimply gut (2.8% of the parasitic conditions and 1.2% of the total kill) and *Cysticercus tenuicollis* (1.2% of the parasitic conditions and 0.5% of the total kill). The total economic loss due to the parasitic conditions in sheep was estimated at US$ 15,550. Most of

Table 1: Percentage occurrence and economic losses due to helminth and other conditions causing whole carcass or specific organ condemnation of cattle carcasses slaughtered in 30 slabs in Nyandarua District of Kenya over a period of one year (1994 – 95).

<table>
<thead>
<tr>
<th>Condition</th>
<th>No. of Animals</th>
<th>% of total Kill</th>
<th>% of all conditions</th>
<th>Approximate Value in US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Liver flukes (Fasciola)</td>
<td>815</td>
<td>15.5</td>
<td>82.5</td>
<td>6,250</td>
</tr>
<tr>
<td>2. Pimply gut (Oesophagostomum)</td>
<td>105</td>
<td>2.0</td>
<td>10.6</td>
<td>600</td>
</tr>
<tr>
<td>3. Stomach flukes (Paramphistomes)</td>
<td>63</td>
<td>1.2</td>
<td>6.4</td>
<td>360</td>
</tr>
<tr>
<td>4. Cysticercus bovis</td>
<td>2</td>
<td>0.04</td>
<td>0.2</td>
<td>800</td>
</tr>
<tr>
<td>5. Septic peritonitis</td>
<td>3</td>
<td>0.06</td>
<td>0.3</td>
<td>1,200</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>988</strong></td>
<td><strong>10.8</strong></td>
<td><strong>100</strong></td>
<td><strong>8,880</strong></td>
</tr>
</tbody>
</table>

Table 2: Percentage occurrence and economic losses due to helminth conditions causing condemnation of organs in sheep slaughtered in 30 slaughter slabs in Nyandarua District of Kenya over a period of one year (1994 – 95).

<table>
<thead>
<tr>
<th>Condition</th>
<th>No. of Animals</th>
<th>% of total Kill</th>
<th>% of all conditions</th>
<th>Approximate Value in US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Liver flukes (Fasciola)</td>
<td>2,112</td>
<td>35.4</td>
<td>83.5</td>
<td>13,200</td>
</tr>
<tr>
<td>2. Pimply gut (Oesophagostomum)</td>
<td>316</td>
<td>5.3</td>
<td>12.5</td>
<td>1,975</td>
</tr>
<tr>
<td>3. Stomach flukes (Paramphistomes)</td>
<td>72</td>
<td>1.2</td>
<td>2.8</td>
<td>264</td>
</tr>
<tr>
<td>4. Cysticercus bovis</td>
<td>30</td>
<td>0.5</td>
<td>1.2</td>
<td>110</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,530</strong></td>
<td><strong>42.4</strong></td>
<td><strong>100</strong></td>
<td><strong>15,550</strong></td>
</tr>
</tbody>
</table>
the losses were due to liver flukes (approximately US$ 13,200) and Stilesia hepatica (US$ 1,795) which resulted in condemnation of livers.

For cattle, the highest proportion of livers condemned due to Fasciola was in slaughter slabs in Ol-Joro-Orok Division (22%) followed by Kinangop Division (16%) and Ol-Kalau Division (16%). The highest rate of liver condemnation due to Fasciola for sheep was in slaughter slabs located in Ol-Kalau Division (44.8%) followed by Ol-Joro-Orok Division (42%) and Kinangop Division (36.6%).

Discussion and Conclusions

The information obtained from this survey was from a large number (approximately 55%) of all the cattle and sheep slaughtered in Nyandarua District during the study period 1994 - 95. Occurrence of the parasitic conditions recorded in the selected slaughter slabs should, therefore, give a good indication of their occurrences in the entire district.

From this study, it is evident that helminth infections in cattle and sheep in Nyandarua District cause considerable economic losses as a result of condemnation of whole carcasses or of specific organs. The major cause of the losses recorded at slaughter in both cattle and sheep during the present study was infection with Fasciola which resulted in condemnation of infected livers. This is in agreement with previous studies\(^3\) on causes or organ condemnation in ruminants slaughtered in Nairobi, Kenya. Fasciolosis in ruminants also caused economic losses due to abortions, retarded growth, decreased milk yield in cattle and wool production in sheep and increased susceptibility to other diseases\(^7\)\(^8\)\(^9\). In addition, there may be losses due to deaths as a result of acute infections as has been reported previously on farms in the district\(^6\). The three divisions (Ol-Kalau, Ol-Joro-Orok and Kinangop) where the highest rate of liver condemnation due to Fasciola in both cattle and sheep receive relatively higher rainfall and have areas which are flat with accumulation of water masses compared with Kipipiri and Ndaragwa Divisions. This may account for the higher rate of infection for animals in these areas.

It is concluded that liver fluke infection is a major constraint to cattle and sheep production in Nyandarua District of Kenya. Strategies aimed at controlling the parasites should be intensified to minimize these losses.

Acknowledgements

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References


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ETUDE DE L’EVOLUTION PONDERALE DES BOVINS DE RACE GUDALI A BAMBU 
DANS LE NORD-OUEST DU CAMEROUN

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STUDY ON THE EVOLUTION OF WEIGHT OF CATTLE OF GUDALI BREED IN BAMBUI IN 
THE NORTH-WEST OF CAMEROON

Abstract 
The analysis of data regarding the evolution of weight of the Gudali cattle obtained from the Bambui Station has revealed that:  
1. The mature age was reached around seven years of age and is 421 kg for males and 355 kg for female animals  
2. Four main factors significantly influence the growth performance, these are birth weight, month of birth, year of birth and the age of the animal.  
3. Different models predicting weight at any age were obtained provided factors mentioned above are known. These models can be used when comparing weight gain of different animals within the breed.

Key words: Cattle, Gudali, growth, selection, predicted weight, maximum weight. Cameroon.

Résumé 
L’analyse des données sur le poids vif des bovins de race Gudali obtenus de la Station de recherche zootéchnique et vétérinaire (IRZV) de Bambui ont permis de tirer les conclusions suivantes:  
1. Le poids à maturité est atteint à l’âge de 7 ans et se situe à une moyenne de 421 kg pour les mâles et 355 kg pour les femelles.  
2. Quatre facteurs principaux influencent significativement l’évolution pondérale: le poids à la naissance, le mois de naissance, l’année de naissance et l’âge de l’animal.  
3. Des index permettant de prédire le poids des animaux ont été élaborés à condition que les facteurs précédemment cités soient connus. Ces équations peuvent être utilisées pour correction, en comparant le gain de poids de différents animaux de race Gudali.

Mots clés: Bovins, Gudali, croissance, sélection, poids prédit, poids maximal. Cameroun.

Introduction 
Au Cameroun, les races les plus communes pour la production de viande sont: le Gudali, le zébu Bororo (red Fulani) et le Aku (white Fulani). Les taurins ne constituent qu’une minorité du cheptel: il s’agit des N’dama, Muturuk Bakos, Namchi et Kapsiki. De toutes ces races, le Gudali s’est révélé posséder le potentiel le plus important en croissance. Or, la croissance pondérale est l’une des caractéristiques les plus importantes en production bovine. Hill (1988) a souligné que le poids à maturité du Gudali variait entre 350 et 560 kg pour les mâles et que entre 4 et 5 ans beaucoup d’animaux pesaient entre 400 et 520 kg. L’âge à la première mise bas se situait entre 3 et 4 ans et les taureaux de reproduction étaient utilisés pour la première fois à 3 ans.

L’Institut de recherches zootéchniques et vétérinaires, dont la tâche est d’améliorer la production animale dans le pays, avait entrepris une opération de recherche de sélection de la race Gudali. L’un des problèmes qui se posaient était le grand nombre de taureaux à prendre en
compte jusqu'à l'âge de la reproduction avant de faire la sélection, augmentant ainsi les problèmes de conduite du troupeau. Pourtant, si le poids de chaque animal pouvait être estimé d'avance, un pourcentage du troupeau pourrait être écarté sans pour autant diminuer la pression de sélection. Ensuite, une des méthodes les plus courantes de sélection des taureaux au Cameroun est de choisir le plus gros taureau du troupeau, soit de choisir le plus gros des taureaux nés à la même année. Ce genre de sélection ignore les facteurs environnementaux tels que le poids à la naissance et le mois de naissance. Ce dernier donne une indication sur les fluctuations saisonnières et sur la disponibilité des fourrages. Prendre en considération beaucoup plus de facteurs environnementaux pour prédire le poids augmente la détermination de la valeur génétique approchée des animaux.


**Matériel et Méthode**

**Origine des Données**

Selon les éleveurs Peuhl du Nord Ouest du Cameroun, les bovins Gudali qu'ils élèvent ont pour provenance Banyo et l'Adamaoua. De même, les animaux élevés à la SRZV de Bambui ont été achetés les uns chez les éleveurs Fulani et les autres importés de l'Adamaoua et acheminés à pied vers la station (distance de plus de 700 km). Ils ont été élevés à l'extension "B", un ranch distancé d'une douzaine de km des services administratifs de la station. Il est situé entre 1700m et 2000m d'altitude avec *Sporobolus africanus* pour espèce dominante dans les pâturages. Les animaux ont parfois eu un supplément protéique en saison sèche. Ils ont aussi parfois eu des interventions vétérinaires selon la disponibilité. L'eau n'est pas un problème primordial au ranch.

Les données enregistrées à la station (incomplètes pour certains animaux) concernent 942 animaux et leur évolution pondérale jusqu'à 84 mois (417 femelles et 425 mâles). Les relevés ont été faits entre 1963 et 1990. Le poids à la naissance était enregistré le jour de naissance. Jusqu'à 13 semaines, les veaux ont eu une pesée hebdomadaire. A partir de 4 mois, les animaux étaient pesés une fois par mois à une date spécifique et le poids était inscrit à main levée sur les cartes individuelles.

**Analyse Statistique**

Les données ont été divisées en 4 groupes selon l'âge

1. Premier groupe: de la naissance à 12 mois.
2. Deuxième groupe: de plus de 12 mois (>12) à 24 mois.
3. Troisième groupe: de plus de 24 mois (>24) à moins de 36 mois (<36)
4. Quatrième groupe: 36 mois et plus.

L'analyse de covariance a été faite avec le logiciel SAS pour pouvoir déterminer les facteurs pouvant aider à la prédiction du poids. Pour chaque groupe, la variable dépendante était le poids maximal et une seule donnée sur le poids a été retenue pour chaque animal. Il est important de noter que dans chaque groupe le poids maximal est atteint à différents âges à cause des sorties ou d'autres facteurs, ce qui permet que la variable dépendante soit dispersée dans tout l'intervalle. L'analyse était faite séparément pour chaque sexe.

Les caractéristiques de croissance dans les deux sexes ont été déterminées à l'aide de l'équation de Gompertz sur les poids moyens à différents âges:

\[ C=C_{m} \exp \left(-\exp\left(-b\ast(t-T)\right)\right) \]

\[ C=\text{poids vif de l'animal au temps} \ t \]

\[ C_{m}=\text{poids maximal} \]

\[ b=\text{taux de baisse de la croissance} \]

\[ T=\text{âge au taux de croissance le plus élevé} \ (\text{point inflexion}) \]

**Résultats**

Le Tableau 1 montre les causes des sorties. Les mortalités s'étendent à 31 pour cent du total des sorties sur les 27 ans. Les femelles ont un plus grand pourcentage de mortalités, 12 pour
cent de plus que les mâles. Le Tableau 2 indique les variations des naissances et des mortalités en fonction des mois de l’année.

Il y a un effet significatif (P<0,1%) de l’année de naissance sur l’évolution pondérale. Le poids à la naissance varie avec le mois de naissance pour les vaches (P=2%) mais pas pour les taureaux (P=5%).

Le Tableau 3 montre les poids moyens des animaux par groupe d’âge. Le poids à maturité des mâles se situe autour de 421 kg. Le paramètre T indique l’âge de puberté. Cet âge est de 16 mois pour les taureaux et un peu moins pour les génisses. Mis à part l’année de naissance, les autres facteurs qui peuvent influencer le poids vif sont: le poids à la naissance (W0), l’âge (Âge) et le mois de naissance. L’âge est la racine carrée de l’âge exprimée en semaines qui a une plus grande relation linéaire avec la variation pondérale. Les Tableaux 5 à 10 rapportent les différents modèles de régression pondérale. Les effets des influences précédemment citées sur le poids maximal ont montré qu’il y avait une interaction significative (P<5%) entre le poids à la naissance et l’âge pour les femelles et jusqu’à un an seulement. Les corrélations (R²) entre les analyses avec ou sans interactions étaient similaires. Alors, seules les analyses faites sans interactions étaient retenues.

Les poids des 2 sexes dans le premier groupe ont suivi le modèle suivant:

\[ Y_{ij} = \mu + \delta_i + \beta_j + \bar{u}_k + e_{ijk} \]

\( \mu, \delta, \beta, \bar{u} = \) constantes

\( i = \) poids à la naissance

\( j = \) mois de naissance

\( k = \) âge (racine carrée de l’âge exprimée en semaines)

\( e_{ijk} = \) variable résiduelle

De 12 à 24 mois d’âge, le mois de naissance n’a pas d’effet dans les 2 sexes. R² est réduit. Ce qui montre que l’influence de l’environnement sur le gain de poids décroît. Les poids peuvent être prédits par l’équation suivante.

\[ Y_{ik} = \mu + \delta_i + \bar{u}_k + e_{ik} \]

\( e_{ik} = \) variable résiduelle

De 2 ans à maturité, le poids à la naissance cesse d’avoir une influence significative sur la croissance des taureaux (P>5%). Mais l’effet saisonnier du mois de naissance réapparaît.

\[ Y_{ik} = \mu + \beta_j + \bar{u}_k + e_{ik} \]

\( e_{ik} = \) variable résiduelle

Chez les femelles, les modèles de croissance entre 24 et 36 mois sont similaires à ceux du deuxième groupe. Mais à partir de 3 ans, seul l’âge a un effet significatif sur le poids vif (P<0,1%).

\[ Y_{ik} = \mu + \delta_i + \bar{u}_k + e_{ik} \]

La régression linéaire du gain de poids post sevrage (de 9 à 24 mois) sur le poids au sevrage montre que les animaux les plus lourds au sevrage gagnent moins de poids jusqu’à 24 mois (P<5%). Le coefficient de régression des mâles est de -0,0012 kg; celui des femelles est de -0,0007 kg. La corrélation du poids à 24 mois avec celui du poids à 36 mois était de 0,66 pour les mâles et 0,60 pour les femelles. Les corrélations de gain de poids post-sevrage aux deux âges étaient respectivement de 0,60 pour les femelles et 0,67 pour les mâles (P<0,1%).

**Tableau 1:** Causes des sorties

<table>
<thead>
<tr>
<th>Mortalités</th>
<th>Abattages d’urgence</th>
<th>Ventes sur pied</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nombre de femelles</td>
<td>97</td>
<td>37</td>
<td>23</td>
</tr>
<tr>
<td>Pourcentage</td>
<td>38</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>Nombre de mâles</td>
<td>88</td>
<td>30</td>
<td>66</td>
</tr>
<tr>
<td>Pourcentage</td>
<td>26</td>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>185</td>
<td>67</td>
<td>89</td>
</tr>
</tbody>
</table>

Pourcentage par rapport aux sorties | 30,9 | 11,2 | 14,9 | 43 | 100 |

a: Pour 343 animaux, il n’y avait aucune donnée de sortie
Tableau 2: Dynamique des mortalités pendant la période d'étude*

<table>
<thead>
<tr>
<th>Mois de naissance</th>
<th>Nombre de naissances</th>
<th>Poids à la naissance des mâles (kg)</th>
<th>Poids à la naissance des femelles (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Janvier</td>
<td>5</td>
<td>22</td>
<td>24</td>
</tr>
<tr>
<td>Février</td>
<td>14</td>
<td>22</td>
<td>24</td>
</tr>
<tr>
<td>Mars</td>
<td>180</td>
<td>23</td>
<td>22</td>
</tr>
<tr>
<td>Avril</td>
<td>259</td>
<td>25</td>
<td>24</td>
</tr>
<tr>
<td>Mai</td>
<td>128</td>
<td>25</td>
<td>23</td>
</tr>
<tr>
<td>Juin</td>
<td>146</td>
<td>25</td>
<td>23</td>
</tr>
<tr>
<td>Juillet</td>
<td>80</td>
<td>25</td>
<td>24</td>
</tr>
<tr>
<td>Août</td>
<td>78</td>
<td>26</td>
<td>24</td>
</tr>
<tr>
<td>Septembre</td>
<td>26</td>
<td>26</td>
<td>25</td>
</tr>
<tr>
<td>Octobre</td>
<td>7</td>
<td>25</td>
<td>22</td>
</tr>
<tr>
<td>Novembre</td>
<td>7</td>
<td>-</td>
<td>24</td>
</tr>
<tr>
<td>Décembre</td>
<td>10</td>
<td>27</td>
<td>21</td>
</tr>
</tbody>
</table>

*a: 34 animaux n'avaient pas d'enregistrement de leur mois de naissance

Tableau 3: Poids moyen jusqu'à l'âge de 84 mois*

<table>
<thead>
<tr>
<th></th>
<th>Mâles</th>
<th>Femelles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semaine 0</td>
<td>25 ± 4</td>
<td>23 ± 4</td>
</tr>
<tr>
<td>Semaine 4</td>
<td>40 ± 7</td>
<td>39 ± 7</td>
</tr>
<tr>
<td>Semaine 8</td>
<td>53 ± 10</td>
<td>51 ± 10</td>
</tr>
<tr>
<td>Semaine 13</td>
<td>70 ± 14</td>
<td>67 ± 13</td>
</tr>
<tr>
<td>6 Mois</td>
<td>106 ± 25</td>
<td>102 ± 34</td>
</tr>
<tr>
<td>12 Mois</td>
<td>153 ± 31</td>
<td>136 ± 32</td>
</tr>
<tr>
<td>18 Mois</td>
<td>181 ± 38</td>
<td>163 ± 35</td>
</tr>
<tr>
<td>24 Mois</td>
<td>213 ± 49</td>
<td>193 ± 47</td>
</tr>
<tr>
<td>36 Mois</td>
<td>293 ± 61</td>
<td>256 ± 54</td>
</tr>
<tr>
<td>48 Mois</td>
<td>328 ± 67</td>
<td>299 ± 50</td>
</tr>
<tr>
<td>60 Mois</td>
<td>377 ± 76</td>
<td>318 ± 52</td>
</tr>
<tr>
<td>72 Mois</td>
<td>417 ± 80</td>
<td>331 ± 51</td>
</tr>
<tr>
<td>84 Mois</td>
<td>435 ± 70</td>
<td>335 ± 49</td>
</tr>
</tbody>
</table>

*a: moyenne ± erreur absolue

Tableau 4: Paramètres de Gompertz

<table>
<thead>
<tr>
<th></th>
<th>Cm (kg)</th>
<th>b</th>
<th>T (Jours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mâles</td>
<td>421</td>
<td>1,6 x 10^3</td>
<td>490</td>
</tr>
<tr>
<td>Femelles</td>
<td>355</td>
<td>1,4 x 10^3</td>
<td>470</td>
</tr>
</tbody>
</table>

Cm estime le poids à maturité.
b est la baisse du taux de croissance
T est l'âge au taux de croissance le plus élevé

Tableau 5: Prédiction du poids des mâles jusqu'à l'âge de 12 mois*

<table>
<thead>
<tr>
<th>Mois de naissance</th>
<th>Poids prédit (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Janvier</td>
<td>-63 + 2,4 W0 + 21,4 √âge</td>
</tr>
<tr>
<td>Février</td>
<td>-33 + 2,4 W0 + 21,4 √âge</td>
</tr>
<tr>
<td>Mars</td>
<td>-42 + 2,4 W0 + 21,4 √âge</td>
</tr>
<tr>
<td>Avril</td>
<td>-49 + 2,4 W0 + 21,4 √âge</td>
</tr>
<tr>
<td>Mai</td>
<td>-52 + 2,4 W0 + 21,4 √âge</td>
</tr>
<tr>
<td>Juin</td>
<td>-58 + 2,4 W0 + 21,4 √âge</td>
</tr>
<tr>
<td>Juillet</td>
<td>-59 + 2,4 W0 + 21,4 √âge</td>
</tr>
<tr>
<td>Août</td>
<td>-65 + 2,4 W0 + 21,4 √âge</td>
</tr>
<tr>
<td>September</td>
<td>-55 + 2,4 W0 + 21,4 √âge</td>
</tr>
<tr>
<td>Octobre</td>
<td>-50 + 2,4 W0 + 21,4 √âge</td>
</tr>
<tr>
<td>November</td>
<td>-47 + 2,1 W0 + 21,6 √âge</td>
</tr>
<tr>
<td>Décembre</td>
<td>-72 + 2,4 W0 + 21,4 √âge</td>
</tr>
</tbody>
</table>

*: R² = 0,47
P<0,1%

Coefficient de variation (CV) = 0,20;
Résiduelle absolue = 29 kg
W0 = poids à la naissance
√âge= racine carrée de l'âge en semaines

*estimation sans le mois de naissance comme variable à cause de données insuffisantes au mois de Novembre.

Tableau 6: Poids prédit des femelles jusqu'à l'âge de 12 mois*

<table>
<thead>
<tr>
<th>Mois de naissance</th>
<th>Poids prédit (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Janvier</td>
<td>-52 + 1,73 W0 + 18,1 √âge</td>
</tr>
<tr>
<td>Février</td>
<td>-26 + 1,73 W0 + 18,1 √âge</td>
</tr>
<tr>
<td>Mars</td>
<td>-21 + 1,73 W0 + 18,1 √âge</td>
</tr>
<tr>
<td>Avril</td>
<td>-23 + 1,73 W0 + 18,1 √âge</td>
</tr>
<tr>
<td>Mai</td>
<td>-23 + 1,73 W0 + 18,1 √âge</td>
</tr>
<tr>
<td>Juin</td>
<td>-27 + 1,73 W0 + 18,1 √âge</td>
</tr>
<tr>
<td>Juillet</td>
<td>-35 + 1,73 W0 + 18,1 √âge</td>
</tr>
<tr>
<td>Août</td>
<td>-39 + 1,73 W0 + 18,1 √âge</td>
</tr>
<tr>
<td>September</td>
<td>-20 + 1,73 W0 + 18,1 √âge</td>
</tr>
<tr>
<td>Octobre</td>
<td>-34 + 1,73 W0 + 18,1 √âge</td>
</tr>
<tr>
<td>November</td>
<td>-3 + 1,73 W0 + 18,1 √âge</td>
</tr>
<tr>
<td>Décembre</td>
<td>-26 + 1,73 W0 + 18,1 √âge</td>
</tr>
</tbody>
</table>

*: P<0,1%
R² = 0,68

Coefficient de variation = 21
Résiduelle = 25 kg
W0 = poids à la naissance
√âge= racine carrée de l'âge exprimée en semaines
Tableau 7: Poids prédit dans les deux sexes entre 12 et 24 mois d’âge*

<table>
<thead>
<tr>
<th></th>
<th>Mâles</th>
<th>Femelles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poids Prédit (kg)</td>
<td>-116 +2.2 WO +</td>
<td>-101 +2.4 WO +</td>
</tr>
<tr>
<td></td>
<td>27 √âge</td>
<td>24 √âge</td>
</tr>
<tr>
<td>R²</td>
<td>0,19</td>
<td>0,17</td>
</tr>
<tr>
<td>Coefficient de variation</td>
<td>0,21</td>
<td>0,21</td>
</tr>
<tr>
<td>Résiduelle (kg)</td>
<td>43</td>
<td>38,5</td>
</tr>
</tbody>
</table>

* p<0.1%
√âge= racine carrée de l'âge exprimée en semaines

Tableau 8: Poids prédit des femelles à plus de 24 mois d’âge*

<table>
<thead>
<tr>
<th></th>
<th>&lt;24 mois et &lt;36</th>
<th>A partir de 36 mois</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poids Prédit (kg)</td>
<td>-132 +2.2 WO +</td>
<td>179+10 √âge</td>
</tr>
<tr>
<td></td>
<td>28 √âge</td>
<td>24 √âge</td>
</tr>
<tr>
<td>R²</td>
<td>0,10</td>
<td>0,10</td>
</tr>
<tr>
<td>Coefficient de variation</td>
<td>0,19</td>
<td>0,15</td>
</tr>
<tr>
<td>Résiduelle</td>
<td>48</td>
<td>52</td>
</tr>
</tbody>
</table>

* P< 0.1%
√âge= racine carrée de l'âge exprimée en semaines

Tableau 9: Poids prédit des mâles entre 24 et 36 mois d’âge (> 24 et <36) *

<table>
<thead>
<tr>
<th>Mois de naissance</th>
<th>Poids prédit (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Janvier</td>
<td>-62+28 √âge</td>
</tr>
<tr>
<td>Février</td>
<td>-49+28 √âge</td>
</tr>
<tr>
<td>Mars</td>
<td>-77+28 √âge</td>
</tr>
<tr>
<td>Avril</td>
<td>-44+28 √âge</td>
</tr>
<tr>
<td>Mai</td>
<td>-33+28 √âge</td>
</tr>
<tr>
<td>Juin</td>
<td>-46+28 √âge</td>
</tr>
<tr>
<td>Juillet</td>
<td>-20+28 √âge</td>
</tr>
<tr>
<td>Août</td>
<td>19+28 √âge</td>
</tr>
<tr>
<td>Septembre</td>
<td>-5,8+28 √âge</td>
</tr>
<tr>
<td>Octobre</td>
<td>-3+22 √âge</td>
</tr>
<tr>
<td>Novembre</td>
<td>-3+22 √âge</td>
</tr>
<tr>
<td>Décembre</td>
<td>-63+28 √âge</td>
</tr>
</tbody>
</table>

* P = 0.2%
Coefficient de variation = 0,21
Résiduelle = 60 kg et R² = 0,19

*: L’estimation omet le mois de naissance comme variable à cause des données insuffisantes aux mois d’octobre et novembre.
√âge= racine carrée de l’âge exprimée en semaines

Tableau 10: poids prédit des mâles a partir de 36 mois d’âge*

<table>
<thead>
<tr>
<th>Mois de naissance</th>
<th>Poids prédit (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Janvier</td>
<td>-54+27 √Age</td>
</tr>
<tr>
<td>Février</td>
<td>-67+27.5 √Age</td>
</tr>
<tr>
<td>Mars</td>
<td>-89+27 √Age</td>
</tr>
<tr>
<td>Avril</td>
<td>-89+27 √Age</td>
</tr>
<tr>
<td>Mai</td>
<td>-43+27 √Age</td>
</tr>
<tr>
<td>Juin</td>
<td>-30+27 √Age</td>
</tr>
<tr>
<td>Juillet</td>
<td>-45+27 √Age</td>
</tr>
<tr>
<td>Août</td>
<td>-58+27 √Age</td>
</tr>
<tr>
<td>Septembre</td>
<td>-61+27 √Age</td>
</tr>
<tr>
<td>Octobre</td>
<td>-67+27.5 √Age</td>
</tr>
<tr>
<td>Novembre</td>
<td>-67+27.5 √Age</td>
</tr>
<tr>
<td>Décembre</td>
<td>-94+27 √Age</td>
</tr>
</tbody>
</table>

*: P<0.1% et R² = 0,52

Coefficient de variation (CV) = 17 kg
Résiduelle = 63 kg
√âge= racine carrée de l’âge exprimée en semaines
*: Cette estimation ne tient pas compte du mois de naissance comme variable à cause d'un nombre de données insuffisantes aux mois de février, d'octobre et novembre.
(R² = 0,31; CV = 20 et variable résiduelle = 72 kg

Discussion

Si les femelles ont un plus grand pourcentage de mortalités par rapport aux mâles, c'est probablement parce que les taureaux sont abattus ou vendus plus tôt. Ils sont gardés dans le troupeau pour une plus courte période et par conséquent ont moins de chance de mourir. L'effet significatif de l'année de naissance doit être dû aux fluctuations climatiques, à l'influence des maladies ainsi qu'à la gestion variable du troupeau. Toutefois il est impossible de prévoir cet effet. Pour le premier groupe, le poids maximal prédit est plus précis à 12 mois parce que peu d'animaux ont un poids élevé qui décline ensuite dans la première année de leur existence.

Le poids à la naissance

Le fait que le poids à la naissance ne varie pas avec le mois de naissance pour les mâles ne
permet pas qu'on puisse planifier l'obtention des veaux lourds à une période donnée de l'année. Les valeurs du poids à la naissance obtenue ici (23 kg pour les femelles et 25 pour les mâles) sont semblables à celles indiquées par Saint-Martin *et al.* (1988) sur les Gudali à Wakwa (23 kg pour les femelles et 24,8 kg pour les mâles). En plus, ils ont trouvé que les vaches ayant un poids plus élevé à la mise bas donnaient également des veaux plus lourds qui croissaient plus rapidement jusqu'au sevrage. Le poids à la naissance influence la croissance des mâles jusqu'à 24 mois et celle des femelles jusqu'à 36 mois.

**Le mois de naissance**

C'est une indication de la saison de naissance. En effet, les veaux nés en début de saison des pluies (Mars-Avril-Mai) sont plus lourds à un an. Ceci doit être dû au fait que leur naissance correspond à une période d'abondante fourrager permettant la production de beaucoup de lait pour les veaux. Avec ce bon démarrage, ils sont plus robustes pour affronter la saison sèche. Dans un système d'élevage amélioré, on peut donc programmer une saison de monte, donc les naissances coïncident avec le début de la saison des pluies. Surtout si l'objectif principal est d'avoir des veaux lourds à un an. Mais dans un tel système, le sevrage tardif (9 mois) retarderait la fertilité des vaches qui allaiteraient encore pendant la saison sèche (IRZV, 1984). Pourtant les veaux surviennent mieux. Le mois de naissance n'a d'effet pour les veaux que jusqu'à 12 mois. Après quoi l'effet disparaît. Chez les mâles, il est aussi mis en évidence tout au long de la vie de l'animal quoiqu'il soit absent entre 12 et 24 mois. Cette observation montre que à IRZV Bambui, les taureaux Gudali sont particulièrement affectés par la disponibilité fourrager et que au cours d'une année, leur poids le plus élevé est atteint quand l'herbe est abondante. Planchenault *et al.* (1986) ont aussi mis en évidence un effet saisonnier chez les mâles N'dama. Mais seulement pour une période allant jusqu'à 90 jours après la naissance. Landais (1983) aussi trouve un effet saisonnier jusqu'au sevrage. Le fait que les vaches ne présentent pas d'effet pondéral saisonnier est dû au fait que leur poids est plus dépendant des vêlages. Carew *et al.* (1986) ont aussi signalé dans leurs expériences de croisements N'dama X Sahiwal que la saison de naissance n'avait d'effet que jusqu'à 12 mois.

**Conclusion**

Cet étude a permis de trouver des index permettant de prédire le poids d'un veau Gudali dès sa naissance à Bambui si le sexe, le poids et le mois de naissance sont connus. Ces résultats permettent de corriger les poids des animaux dans une opération de sélection dont le but serait le gain de poids post-sevrage. Quoique le poids à maturité ait été déterminé à 421 kg, certains animaux atteignent 600 kg. Ce qui montre que la variance phénotypique est large et qu'il y a grand espoir d'un bon progrès en sélectionnant la croissance pondérale.

Les veaux les plus lourds à 9 mois (sevrage) le sont surtout à cause de la production laitière des mères. Le fait que le coefficient de régression du gain de poids post-sevrage sur le poids au sevrage soit négatif dénote que les veaux les plus lourds au sevrage sont moins habitués aux pâturages que les veaux dont les mères ne donnaient pas assez de lait. C'est pourquoi dans une opération de sélection, des relevés de poids à prendre en considération devraient laisser une période d'adaptation (commencer 3 mois au moins après sevrage par exemple, ici 12 mois). La corrélation entre le gain de poids de 12 à 24 mois et de 12 à 36 mois est assez élevée (voir résultats). Il est donc suggéré que dans une opération de sélection il puisse y avoir une sélection initiale de 50% des sevrés les plus satisfaissants à 24 mois et un deuxième stade de sélection à 36 mois. Les poids à 12, 24 et 36 mois peuvent être corrélés comme déviations des poids réels par rapport aux poids prédits dans cette étude. Étant donné que l'année de naissance a un effet très significatif, les animaux ayant différentes années de naissance peuvent être comparés sur la base de la déviation de chaque animal par rapport à la moyenne des déviations des animaux de son
année de naissance (cette dernière moyenne est celle des déviations des poids réels par rapport aux poids prédits).

Remerciements
Je voudrais ici remercier l’Université de Reading pour les analyses statistiques et le Professeur Morris pour ses avis.

Bibliographie

Reçu pour publication le 13 Septembre 1999
SHORT COMMUNICATION

PROJECTILE DIARRHOEA IN A COW ATTRIBUTED TO TRAUMATIC RETICULO-DUODENITIS

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Cattle are not carefully selective feeders, do not thoroughly masticate their ingesta before swallowing, and often do not discriminate against hard non-feed materials. Zerograzed cattle will thus ingest materials such as nails, wires, ropes etc. accidentally or carelessly if dropped in their feeding troughs¹. Most of these materials especially the metallic ones are trapped in the reticulum and often perforate the organ²³. Due to the biphasic rumino-reticular contractions, the sharp objects penetrate the reticular wall causing gastritis and indigestion. After the object perforates the reticular wall, it may involve the peritoneum, pericardium, myocardium, pleura, lungs, mediastinum, diaphragm, liver and spleen, causing inflammation in the affected organs⁴⁵.

The reticulum anatomical position relates directly with the rumen, omasum, left lobe of the liver, the diaphragm and the cranial part of the fundus of the abomasum. The position of the abomasum is not fixed, and varies according to the fullness of the organ, its intrinsic muscular activity and the contractions of the reticulum and rumen⁶⁷. The changing position of the abomasum, in turn, drags the duodenum along.

A case of projectile diarrhoea in an adult Friesian cow kept under the zero-grazing system was reported to the Ambulatory Clinic (AC) of the Faculty of Veterinary Medicine, Makerere University. The cow was nursing a month old calf. On clinical examination the temperature was normal, the respiratory and heart rates were also normal. The stool, however, was projectile but with no discoloration or abnormal smell. Ruminal movements were regular and there was no clinical evidence of toxaemia. At first the case was diagnosed as dietary diarrhoea and a change to a more fiber diet was advised. A stool sample taken from the animal was negative for helminths and acid-fast bacilli by the Ziehl-Neelsen’s staining. The blood sample showed no haemo-parasites and the haemogram was normal. Oral boluses of sulphadimidine were administered for three days.

After a week, the diarrhoea had not subsided and another clinical examination was done. There was evidence of pain in the thoraco-abdominal region, the animal grunting on deep palpation of the region and on applying pressure on the withers. The elbows by this time were abducted and the animal resisted movement. The test for the presence of metals was positive when the area around the xiphoid was scanned with a metal detector (VET-TEC). A laparorumenotomy was performed and three wire nails were retrieved from the reticulum. One of them, approximately three inches, was stuck in the reticular wall in a right ventro-posterior direction. Post operative care with a penicillin-streptomycin (Dipen, Bimeda Veterinary Pharmaceuticals) for five days was done. At the time of removal of sutures, intravenous electrolyte fluids and substitute ruminal contents were given by stomach tube, fearing that the ruminal flora had been compromised. The diarrhoea, however, persisted and the case was judged to have a hopeless prognosis. It was salvaged and a post-mortem was conducted. Postmortem lesions included dehydration, peritonitis and hydroperitoneum in the form of a sac of sero-fibrinous fluid connecting the rumen, reticulum peritoneum and abomasum. There was necrosis stretching from the reticulum to include part of the abomasal

*Corresponding author
serosa and descending duodenum that marked the extent of the nail. There was scanty material in the entire intestine. After perforation of the reticulum the nail had apparently razed through the serosa of the abomasum (without penetrating its lumen) and pierced the duodenum causing inflammation and fibrosis in the duodenum with near complete stenosis. A further epithelial scraping of the ileum and large intestine was negative for acid-fast bacilli by Ziehl-Neelsen staining. Moreover, there were no intestinal corrugations typical of Johne's disease.

In retrospect, a conclusion was made that the nail could have been forced to perforate the reticulum wall by the pressure of pregnancy and labour, as the cow was nursing a month old calf. While the head of the nail got stuck in the wall of the reticulum, the sharp end passed through the abomasum and a possible rotation of the organ could have led to piercing of the duodenum. The irritation and inflammation so caused could have led to hypermotility of the intestinal muscles leading to the projectile diarrhoea. However, earlier investigators pointed to metallic objects perforating the abomasum leading to pyloric stenosis and hence the observed clinical entity of scanty faeces as opposed to projectile diarrhoea observed in this case. While involvement of the abomasum by a metal from the reticulum has been documented this is the first time a metal going as far as the duodenum has been reported. This, therefore, presented a unique case.

Ingestion of foreign bodies by cows in the zero-grazing system has been reported as a hindrance to production. There is a need for zero-grazers to administer ruminal magnets as this has been observed to reduce incidences of traumatic reticuloperitonitis.

Acknowledgments
The authors wish to acknowledge the assistance of various staff and field veterinarians in the Faculty of Veterinary Medicine, Makerere University, and Dr. Lumbago, the owner of the animal, for collaboration. Appreciation also goes to the Ambulatory Clinic of the Department of Veterinary Medicine whose facilities were utilized in handling this case.

References

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SHORT COMMUNICATION

CONTAGIOUS BOVINE PLEUROPNEUMONIA: SUSCEPTIBILITY OF THREE MYCOPLASMA MYCOIDES SUBSPECIES MYCOIDES SC STRAINS TO SELECTED ANTIMICROBIAL AGENTS

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Contagious bovine pleuropneumonia (CBPP), caused by Mycoplasma mycoides subspecies mycoides SC\(^1\), is one of the most serious diseases of cattle. CBPP outbreaks have occurred in many countries in sub-Saharan Africa causing large losses according to reports by Office International Des Epizooties (OIE)\(^2,3\). The economic importance of CBPP results from losses due to mortality, low fertility, poor growth rate, weight loss and the socio-economic burden that results from restriction of cattle movement, quarantine and vaccination programmes. CBPP remained endemic in south-western Angola, Kaokoland of Namibia, the eastern part of Guinea and parts of eastern Africa\(^4,5,6\). In East Africa CBPP remained in the area comprising, north-eastern Uganda, southern Sudan and north-western Kenya, among the Karamajong, Dinka, Turkana and Maasai nomadic cattle. From this triangle, CBPP spread by cattle movements in the late 1980s and early 1990s to the whole of Uganda, Tanzania, Rwanda, Burundi and Kenya. The devastating 1995 outbreak in Botswana spread from foci in Namibia\(^7\). Spread of CBPP always involves movement of infected live animals coming into contact with susceptible cattle. The disease has been especially associated with nomadic, or at least transhumant cattle. Climatic and seasonal factors can also exert their influences on the disease through their effects on husbandry practices. Although CBPP had been eradicated in most of western Europe, outbreaks are still occurring in Portugal, while France, Italy and Spain have all reported sporadic outbreaks in the last 20 years\(^8,9\). In most African countries strategies towards effective control and eradication of CBPP are not operational or have not been successfully implemented due to economic constraints. As a consequence, in the face of CBPP outbreaks, there has been extensive use of antibiotics, most of which have little effect against mycoplasma infections. The purpose of this investigation was to evaluate the susceptibility of M. m. mycoides SC to seven antibiotics commonly used in the treatment of bovine respiratory infections by determining the minimum inhibitory concentration (MIC) and minimum mycoplasmacidal concentration (MMC).

The susceptibility of strains 192 (Italy), 375 (Botswana) and Afadé (Chad) of M. m. mycoides SC to seven antimicrobial agents was determined. Mycoplasma numbers in each vial of the test strains were estimated by CCU\(_{50}\) (median effective dose that gives positive colour change in 50% of a given number of inoculæ), calculated using the Spearman-Karber method\(^10\). The test mycoplasma broths were standardised to contain 10\(^3\) CCU\(_{50}\) for strain 375, 10\(^3.5\) CCU\(_{50}\) for strain 192 and 10\(^3.7\) CCU\(_{50}\) for Afadé strain per 100\(\mu\)l of inoculum. Antimicrobial agents used in the study were, tylosin (Sigma-Aldrich Co.), Spectinomycin (Sigma-Aldrich Chemie), Ampicillin (Sigma-Aldrich Chemie), Streptomycin (Sigma Aldrich

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Chemie), flornofenicol (Nuflor® - Sheringplough), enrofloxacin (Baytril® - Bayer) and tilmicosin (Micotil® - Elanco). Each of the antimicrobial agents was standardised to a concentration of 256 μg/ml in Eaton’s broth. Eaton’s growth media used in the study comprised PPLO broth base, yeast extract, unheated horse serum, dextrose and DNA\textsuperscript{[11]}. The broth contained phenol red (PR) as indicator. The tests were performed on 96-well U-bottom microtitre plates. Using a multi-channel pipette, 100μl of Eaton’s broth +PR were dispensed into wells of rows A, B, C, D, E and G of the microtitre plates except for the wells of column one. One hundred microliters (100μl) of antimicrobial agent at concentration of 256 μg/ml was added to wells of column one and two rows A,B,C,D,E, and G. Doubling dilutions of the antimicrobial agents were made across the microtitre plates starting from wells of column two. For enrofloxacin, flornofenicol, tilmicosin and tylosin, dilution was continued on a second plate to obtain much higher dilution of the drugs. One hundred microliters (100 μl) of test strain were added to all the wells of rows A,B,C,D,C and G.

Controls of antimicrobial agent, Eaton’s broth +PR media and test strain inocula were made in row H of each plate set up. The plates were sealed with tape and incubated at 37 °C in an atmosphere of 5% CO\textsubscript{2} and 70% humidity. The wells were observed for growth of mycoplasmas shown by the colour change from pink to yellow. The MICs were the lowest concentration (highest dilution) at which there was no colour change by day seven of incubation. The MMCs were determined by subculturing the low dilution wells next to those of the MICs and inoculating into 3ml of fresh Eaton’s media in bijoux bottles. The MMCs were the lowest concentration of antimicrobial agents at which there was no viable growth on subculturing into fresh Eaton’s media.

Enrofloxacin, flornofenicol, tilmicosin and tylosin were diluted over two microtitration plates to achieve final drug concentration ranges of 1.95 x 10\textsuperscript{-4} μg/ml to 128 μg/ml. All three strains were very susceptible to tilmicosin, enrofloxacin, tylosin and flornofenicol. Tilmicosin, enrofloxacin, tylosin and flornofenicol showed strong inhibitory (0.0078 - 0.125g/ml) and cidal (0.5 - 8 μg/ml) properties against the three strains (Table 1).

Tilmicosin apparently showed superior inhibitory (0.0078g/ml - 0.0156 μg/ml) and cidal (0.5 - 1 μg/ml) activity against the three strains. Enrofloxacin showed inhibitory activity at concentration of 0.016 - 0.0311 μg/ml and was cidal at the concentration of 0.5 μg/ml for Afadé strain, 1 μg/ml for strain 375 and 4 μg/ml for strain 192. Tylosin was inhibitory at a concentration of 0.0625 μg/ml for the three strains and was cidal at concentration of 2 μg/ml for strain 375 and 4 μg/ml for strains 192 and Afadé. Spectinomycin was inhibitory at concentrations of 2 μg/ml for strain 192 and 4 μg/ml for strains 375 and Afadé. Streptomycin was inhibitory at concentrations of 16 μg/ml for the three strains. Ampicillin did not show any inhibition to any of the three strains even at 128 μg/ml, the highest concentration used in the experiment.

Although Hudson and Ethridge\textsuperscript{[12]} recommended the use of tylosin as a treatment against CBPP, antibiotics have not played a useful role in the control of the disease. The use of antibiotics against CBPP has been discouraged because they accelerate the progress of the disease to chronic carrier status of ‘lungers’\textsuperscript{[12,13]}. These ‘lungers’ play an important role in the epidemiology of the disease. However, others believe chemotherapy with approved antimicrobial agents could play an important complementary role during vaccination against CBPP\textsuperscript{[14]}. Although considerable work has been done on susceptibility of bovine mycoplasmas to various antimicrobials used in the treatment of respiratory infections\textsuperscript{[15]}, not enough such work has been done with *M. m. mycoides* SC. In this study, tilmicosin showed superior inhibitory activity against the three strains. Similar inhibitory activity has been reported against *M. bovis* and indeed tilmicosin has been found superior to any other antibiotics including long acting oxytetracycline in the treatment of pneumonia caused by mycoplasma and *Pasteurella haemolytica*\textsuperscript{[16,17]}. The MIC values obtained for enrofloxacin in this study were
similar to those reported by other workers for other bovine mycoplasmas\textsuperscript{15,18}. In particular, Laak \textit{et al.}\textsuperscript{19} reported MIC values of 0.52 µg/ml for \textit{M. bovis}. Tilmicosin and enrofloxacin were mycoplasmacidal to the three strains. In the African situation where the use of antibiotics against CBPP cannot be completely avoided, tilmicosin and enrofloxacin could be used to minimise the enormous losses due to the CBPP. However, it should be noted that in Europe, resistance has been reported in \textit{M. bovis} to tilmicosin\textsuperscript{20}. Overuse of this drug for CBPP in Africa could lead to similar resistance developing in \textit{M. m. mycoides SC}. Therefore, there is need for specific in vivo studies to establish the therapeutic value of these drugs against CBPP. Studies on the molecular basis of virulence and immunogenicity of vaccine strains of \textit{M. m. mycoides SC} may be necessary for production of better CBPP vaccines and effective drugs against CBPP.

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### References


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THE PREVALENCE OF ONCHOCERCA OCHENGI IN CATTLE IN UGANDA

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Onchocerca ochengi was first described by Bwangamoi in 1969 in Uganda1. It can be distinguished from other Onchocerca species in cattle by the presence of adults in superficial nodules chiefly in the region of the udder and scrotum. Where lesions are widespread the hide is rendered useless, but more usually the affected udder and scrotal areas can be trimmed prior to tanning. In addition to its being a potential cause of lost leather production, the infection is used in research into the immunology and chemotherapy2 of Onchocerca volvulus, the cause of onchocerciasis in humans. Although O. ochengi was first described in Uganda there is no information on its current prevalence and potential damage to the leather industry.

Three abattoirs which handle cattle were visited in July, 1998. These covered three areas of Uganda, namely Kigumba abattoir which slaughters Ankole and local Nganda cattle and their crosses from central Uganda, Fort Portal abattoir which slaughters Ankole crossed local breeds from Kabarole District (Rift Valley), in western Uganda, and Kampala City abattoir which slaughters Ankole local cattle from Mbarara, central-western Uganda. Financial constraints and the current security situation prevented survey in other areas. At the first two abattoirs every hide was sampled, but in Kampala hides were grouped according to the farms of origin by slaughterhouse workers making it possible to randomly select hides from each region.

The hides were removed following ventral splitting from anus to brisket and the two ventral halves were palpated for nodules, from the umbilicus to the perianal area and laterally to the stifle area. Nodules were differentiated from tick bites by the movement of the epidermal skin with the nodules. Skin snips of known weight (c7 mg) were taken from an excised sample of skin near the udder or scrotum and incubated in phosphate buffered saline at 37°C for 30 minutes in a 96 well plate. Previous studies (unpublished) had shown this to be the optimum condition for emergence of the larvae. The numbers of larvae were counted using an inverted microscope. Nodules were dissected from the skin and digested by the Schulzkey method3 and worms were confirmed to be O. ochengi by Professor Bwangamoi. Some nodules and live worms were recorded.

The results of the survey are given in Table 1. There was a great variation in microfilarial counts from one piece of skin taken from one hide and ranged from 1-400 in a skin snip. Kruskal-Wallis tests showed a significant difference in mean microfilarial burdens between the three regions, with the highest counts being from the Kampala abattoir and the lowest from Fort Portal. 4.3% of cattle in Kampala had nodules and 5.8% in Kigumba. It is not clear why some cattle had microfilariae in their skin but no detectable nodules. These microfilariae could have been present as a result of O. ochengi from other areas of the body, or other Onchocerca species, such as O.gutturosa, O.gibsoni and O. armillata, which reside in extradermal connective tissue.

Given the relatively flat nature of the land in central and central-western Uganda and therefore, few good breeding places for blackflies, the low percentage of cattle infected
with *O. ochengi* was not surprising. However, the Fort Portal area, which is adjacent to Ruwenzori Mountains, has abundant rainfall and fast flowing streams, ideal habitat for blackflies. However, no nodules were found in cattle from this area. The Fort Portal area is the centre of the WHO Onchocerciasis Control Project (OCP) in Uganda involving largely treatment of humans with ivermectin. Therefore, the above project may not have affected *Onchocerca* in cattle. However, information from the vector control unit revealed that farmers had recently been using a deltamethrin based spray to control tick burdens and that insecticide preparations had been released into streams to reduce the level of onchocerciasis in workers on tea plantations. The results indicate the success of chemical treatment of cattle in preventing biting of cattle by infected blackflies and possibly the result of insecticiding of streams. It is of interest that Fisher, et al. 4 reported that only *O. volvulus* was found in *Simulium neavei* from western Uganda and concluded that very few if any filaria species other than *O. volvulus* are transmitted by *S. neavei* and *S. damnosum* in the same region. An alternative explanation of their findings is that tick control in western Uganda had interrupted transmission of *O. ochengi* and lack of *O. ochengi* in the flies had nothing to do with the strain of the flies.

Unless there is another area of Uganda where there are fast flowing streams and farmers are not treating cattle with insecticides, it can be concluded that *O. ochengi* is not a significant cause of skin damage and loss of hides in Uganda. A more extensive survey would be required to validate this conclusion.

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**References**

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