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The Bulletin of Animal Health and Production in Africa publishes articles on original research relevant to animal health and production activities which may lead to the improvement of the livestock industry in Africa and better utilisation of her animal resources. The journal is published quarterly.

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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 regular.
Results regular.
Discussion regular.
Acknowledgements.
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HEALTH PROBLEMS ASSOCIATED WITH PRODUCTION OF DAIRY COWS IN PERI-URBAN AREAS OF LUSAKA, ZAMBIA

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PROBLEMES SANITAIRES LIES A LA PRODUCTION DE VACHES LAITIERES DANS LES ZONES PERIURBAINES DE LUSAKA EN ZAMBIE

Résumé

La prévalence de huit problèmes sanitaires économiquement importants liés à la production et à la gémissilité était évaluée chez 22 troupeaux laitiers dans les zones périurbaines de la Province de Lusaka en Zambie entre février et août 1998. Les 22 troupeaux comptait au total 1.625 vaches avec une taille moyenne du troupeau de 74 ± 4 vaches. Près de 65% des vaches étaient affectées par au moins un des problèmes de santé ou la gémissilité. La prévalence de la mammité était de 8,4% ; la boiterie (4,1%) ; les vaches traitées à cause de l'anoestru étaient de 15,6% ; la fièvre vitale (1,6%) et la rétention des membranes placentaires (7,6%). La suppuration vulvaire a été observée chez 17,6% des animaux, tandis que le taux de prévalence de la gémissilité enregistré s'élevait à 1,4%. Le taux de mortalité était de 4,4% chez les veaux mis bas pendant la période couverte par l'enquête. Le nombre de vaches ayant bénéficié de l'aide au vêlage s'élevait à 3,9%. La quantité de lait que l'on a dû jeter à cause de la mammité était d'environ 20.000 litres, soit à peine une perte de 0,30% des recettes totales pour les ventes de lait. Les interrelations entre certains problèmes sanitaires sont discutées dans cet article.

Summary

The prevalence of eight economically important production-related health problems and twining were estimated in 22 dairy herds in peri-urban areas of Lusaka Province, Zambia between February and August 1998. The total number of cows in the 22 herds was 1625 with an average herd size of 74±4 cows. Nearly 65% of the cows were affected by at least one of the health problems or twining. The prevalence of mastitis was 8,4%, lameness 4,1%, cows treated for oestrus-not-observed was 15,6%, milk fever was 1,6%, and retained placental membranes affected 7,6% of the animals. Vulval discharge was observed in 17,6%, while the prevalence of twinning was recorded in 1,4% of the animals. Calf mortality claimed 4,4% of the calves born during the period under investigation. The number of cows given aid at calving was 3,9% of the cows calving. The quantity of milk lost through discarding as a result of mastitis was estimated at 20,000 litres representing only a loss of 0,30% of total revenue derived from milk sales. The interrelations between the selected health problems are discussed in this paper.

Introduction

With about 50,000 dairy animals, the Zambian dairy industry provides almost all the marketed dairy products in the country1. However, the industry is yet to reach its maximum potential due to losses arising from diseases and inefficient management2. Apart from vector-borne and other infectious diseases, there are many production-related health problems causing losses or decreasing productivity.
in the Zambian livestock. Peri-parturient diseases (milk fever, retained placenta, vulva discharge, twinning, calf mortality, aid at calving) and other common health problems (mastitis, lameness and salient oestrus) have detrimental effects on the productivity of livestock. A previous report revealed that in 1977 only a little more than 200 herds of dairy cattle of all types and sizes were contributing to milk production. Further more, the 1976 total production was reported to be 12.8 million litres with sales over 42 million litres; the balance was made up by milk reconstituted from imported skim powder and butter oil. The principal measures used to gauge the technical success of the dairy enterprise were average milk for cows in production and in milk dry.

In Zambia, baseline information on production-related health problems of livestock has not been investigated adequately. We believe that there is under estimation of the economic importance of the losses attributable to these problems. Lack of adequate information on animal health problems has been suggested to be one of the major drawbacks in promoting preventive medicine programmes for farm animals.

The objective of this study was to investigate the prevalence and the role of interrelated husbandry practices for some production-related health problems in dairy herds in the peri-urban areas of the Zambian capital city, Lusaka. The results of this survey could make the dairy farmers better informed on the occurrence and relative importance of the selected animal health problems. This approach would be useful in encouraging dairy farmers to adopt high standards of health and production management. In addition, this study could act as a baseline study on which plans for extensive research could be based.

Materials and Methods

The study was carried out in the peri-urban areas of Lusaka town in the Lusaka province of Zambia between February to August 1998. The general climatic condition in Lusaka is characterised by annual rainfall ranging from 800 to 1000 mm. The mean monthly temperatures vary from 18°C in June/July to 33°C in October to March. The study was limited to Lusaka Province because of easy accessibility and most of the peri-urban dairy farmers in Zambia appear to be concentrated in the study area.

The study was based on retrospective data gathering. Farmers were selected purposively based on maintenance of good records of activities in their farms. Previously, a list of the major dairy farms in the study area was requested from the Livestock Cooperative Society of Zambia and a dairy product-marketing company called BONNITA Zambia. From the total of 102 dairy farms obtained, 25 farmers (23% of total) were drawn for interview but three of the selected farmers were dropped due to lack of cooperation. Data collection was by means of questionnaire administered to a group of farmers located in the study area.

Some variables were investigated through oral interviews and records kept and maintained at the farms. Such variables included, dairy-cow inventory in the herd, disease cases, attempts made to control them and production losses involved and management and husbandry practices.

The cases of production-related health problems investigated and their definitions are given in Table 1.

Data of Analysis

Data summarised from the Questionnaire were entered in the spreadsheet program (Microsoft excel) for
Table 1: Definition of production-related health problems investigated

<table>
<thead>
<tr>
<th>Disease/health problem</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oestrus-not-observed</td>
<td>Absence of behavioural signs of oestrus at the first and/or second ovulation postpartum.</td>
</tr>
<tr>
<td>Retained placenta</td>
<td>Placental membranes are considered as retained if not expelled within 24 hours after calving.</td>
</tr>
<tr>
<td>Calf mortality</td>
<td>Death of calf during the first six months of life.</td>
</tr>
<tr>
<td>Clinical parturient paresis</td>
<td>Typical clinical signs like recumbency and reluctance to eat accompanied by fever all occurring after parturition.</td>
</tr>
<tr>
<td>Vulval discharge</td>
<td>Muco-purulent vaginal discharge.</td>
</tr>
<tr>
<td>Aid at calving</td>
<td>Parturition requiring correction in posture or assistance to deliver.</td>
</tr>
<tr>
<td>Lameness</td>
<td>Any condition affecting the foot, or leg resulting in lameness (injuries, joint problems etc).</td>
</tr>
<tr>
<td>Clinical mastitis</td>
<td>Any mammary gland disorder that requires therapy.</td>
</tr>
<tr>
<td>Twinning</td>
<td>Delivery of two calves per parturition.</td>
</tr>
</tbody>
</table>

analysis and presentation of results. The data were analysed using the Microsoft excel programme to obtain descriptive statistics for all the diseases under consideration, highlighting the value of the mean and dispersion statistics.

Results

Table 2 shows the overall prevalence of the health problems and twinning investigated in the 22 dairy cattle farms. The total number of cows in the 22 herds was 1625 of which 65% (1049) were affected by at least one of the eight health problems or twinning. The number of animals affected by the health problems in each herd varied considerably (Table 3). The average herd composition was 74 (mean 41) cows per herd while the average milk production per cow per day was 16 litres (Table 4).
Table 2: Overall prevalence of production-related health problems in the selected dairy farms. Total number of dairy cows from 22 herds = 1625.

<table>
<thead>
<tr>
<th>Disease/health problem</th>
<th>Number of cows affected (number of herds)</th>
<th>% cows affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastitis</td>
<td>136(22)</td>
<td>8.4</td>
</tr>
<tr>
<td>Lameness</td>
<td>67(15)</td>
<td>4.1</td>
</tr>
<tr>
<td>Oestrus-not-observed</td>
<td>254(13)</td>
<td>15.6</td>
</tr>
<tr>
<td>Milk fever</td>
<td>26(9)</td>
<td>1.6</td>
</tr>
<tr>
<td>Retained placenta</td>
<td>123(17)</td>
<td>7.6</td>
</tr>
<tr>
<td>Vulval discharge</td>
<td>286(12)</td>
<td>17.6</td>
</tr>
<tr>
<td>Twinning</td>
<td>23(9)</td>
<td>1.4</td>
</tr>
<tr>
<td>Calf mortality</td>
<td>71(20)</td>
<td>4.4</td>
</tr>
<tr>
<td>Aid at calving</td>
<td>63(14)</td>
<td>3.9</td>
</tr>
<tr>
<td>Total cows affected*</td>
<td>1049(22)</td>
<td>64.6</td>
</tr>
<tr>
<td>Total cows not affected</td>
<td>576(22)</td>
<td>35.4</td>
</tr>
</tbody>
</table>

* Some cows had multiple diseases

The total amount of milk discarded was 20,000 litres (Table 4), which in monetary term is a loss of Zambian Kwacha ZMK8, 151, 200 (which is equivalent to about US$ 2700). Thus a mean of ZMK5 016.12 of income was lost per cow per lactation period for all the 1652 cows in the 22 herds.

Discussion

The prevalence of each of the conditions investigated varied across herds widely. These variations could have been attributed to differences in management practices and husbandry skills of each of the participant farmers.

Clinical mastitis was the most widespread production-related health problem encountered in this study. It usually occurs within six weeks after parturition and is commonly considered as the single most costly disease in the dairy industry. In this investigation, mastitis was the main reason given by the farmers for discarding milk. Loss of milk from mastitis seemed marginal when compared to the total and only represented 0.30% but perhaps became more significant in individual herd especially smaller herds with high prevalence of mastitis.

Lameness affected 4.1% in this investigation. Lameness is considered as a significant cause of reduced performance in both beef and dairy cattle, the reduction being shown as decreased feed intake and efficiency, loss of body weight, lowered milk production and reduced sexual activity.

In this study, the prevalence of Oestrus-not-observed was 15.6%. This figure appeared to be high compared to
those from developed countries thus calling for attention to be paid to it. Oestrus detection has been reported to be difficult in cows with twins or those which have been lame less than 50 days after calving. If oestrus is not observed, it will result in increase in calving to conception interval. This defeats one of the aims of the dairy farmer, which is to produce at least one calf per cow per year. Mismanagement of herd fertility has been reported to be one of the factors responsible for cows not being observed in heat. In this study, most of the reasons given for not detecting heat on time were related to management such as failure to detect heat by inexperienced workers, unreliable record keeping such that the expected time for servicing each individual animal could not be ascertained or probably in other cases the cows showed salient heats.

The milk fever prevalence of 1.6 % in the 22 herds appeared to be low compared to 7.7 % reported by other authors. The prevalence in this study appeared to be localised as many of the animals contributing to the cases came from one herd. Variations between/across herds are commonly expected in milk fever because the condition is influenced by the level of milk yield, the age of the cow, and by nutritional management. Deficiencies in nutrition and in supplies of macro- and microelements in particular, could have been the possible explanation for the observed variations in this study.

In this study, the prevalence of retained placenta was 8 %, which was higher than the 3.6 % reported for dairy cows in England. The problem of retained placenta in this survey appeared to be evenly distributed in the 22 herds, indicating that the problem was not localised in a few herds.

The prevalence of a vulval discharge appeared to be widespread among the 22 herds. Vulval discharge had the highest prevalence (18%) of all the conditions investigated in this survey and was close to the 14.8 % that was reported else where. The prevalence of twinning was 1.4 % from this study. Twinning could cause increased risk of vulval discharge, increased calf mortality and increased number of services per conception. Cows with twins will, however, provide more extra income from sales and increased milk production compared to their herds mates. The prevalence of calf mortality in this study was estimated at 4.4 %. Causes of calf mortality have been identified in the traditional livestock sector in some parts of Zambia. Management problems such as inadequate nutrition and lack of supervision at calving and within the first 24 hours of life have been suggested to be the possible causes of calf mortality in dairy farms in Zambia. In this study, the prevalence of calf mortality ranged from 0-10 %. The most effective way to prevent calf mortality has been suggested to be the elimination of the primary causes.

The prevalence of aid at calving was 3.9%. Most was associated with calves dying at parturition in this study.

Conclusion

All the 22 herds were at least affected by one or more of the eight health problems and twinning. This calls for more awareness creation among the farmers on the impact of these conditions on the productivity of their animals. Measures such as proper recording of the disease occurrence on farms to ensure more accurate diagnosis, control and prevention should be emphasised. This can be achieved by putting in place effective disease control and surveillance systems that should encourage
Table 3: Between herd variability in disease/health problems prevalence in studied dairy herds (n = 22).

<table>
<thead>
<tr>
<th>Disease/health problem category</th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aid at calving</td>
<td>2.86</td>
<td>9.71</td>
<td>6.0</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>Calf mortality</td>
<td>3.23</td>
<td>9.38</td>
<td>8.0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Lameness</td>
<td>3.0</td>
<td>3.45</td>
<td>1.0</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>Mastitis</td>
<td>6.2</td>
<td>3.42</td>
<td>5.0</td>
<td>0</td>
<td>23</td>
</tr>
<tr>
<td>Milk fever</td>
<td>1.18</td>
<td>7.89</td>
<td>5.5</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>Oestrus-not-observed</td>
<td>11.55</td>
<td>11.04</td>
<td>6.5</td>
<td>0</td>
<td>213</td>
</tr>
<tr>
<td>Retained placenta</td>
<td>5.59</td>
<td>7.47</td>
<td>8.5</td>
<td>0</td>
<td>48</td>
</tr>
<tr>
<td>Twinning</td>
<td>1.05</td>
<td>9.44</td>
<td>5.5</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Vulva discharge</td>
<td>13</td>
<td>11.77</td>
<td>6.5</td>
<td>0</td>
<td>250</td>
</tr>
</tbody>
</table>

* Some variables vary greatly between the means and median because some conditions appeared to be localised in a few herds.

Table 4: Loss of Income due to Mastitis in the 22 Herds

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total milk produced in the 22 herds</td>
<td>6 739 035 litres</td>
</tr>
<tr>
<td>Price per litre</td>
<td>@K400.00 per litre</td>
</tr>
<tr>
<td>Total revenue from milk sales</td>
<td>K2 694 814 000.00</td>
</tr>
<tr>
<td>Total milk discarded due to mastitis</td>
<td>20 378 litres</td>
</tr>
<tr>
<td>Revenue lost from discarded milk</td>
<td>K8 151 200</td>
</tr>
<tr>
<td>% of revenue loss due discarded milk</td>
<td>0.30%</td>
</tr>
</tbody>
</table>
the farmers to record and report all disease cases promptly to the veterinary authorities.

There is need to organise the dairy farming information system such that farmers should be made aware of the effects of production-related health problems on cow productivity. Further more, farmers should be in a position to access current information on preventive methods to enable them raise the standards and welfare of the dairy animals. This could be achieved by formation of an information database, which should disseminate information on prevention and control methods.

Acknowledgement

The authors acknowledge the assistance given by the following individuals for supplying the names and addresses of the farmers and helping in the identification of the location of the dairy farms: Mrs Jane Mubanga Chinkusu of BONNITA Zambia, Dr. S Singh of The Livestock Co-operative Society and The Principal, Palabana Dairy Training Institute.

References


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EFFECT OF DIMINAZENE ACETURATE, ISOMETAMIDIOUM CHLORIDE AND TRYPTANOSOMA BRUCEI ON EPIDIDYMAL AND TESTICULAR SPERM RESERVES OF MICE

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EFFET DE L’ACETURATE DE DIMINAZENE, DU CHLORURE D’ISOMETAMIDIOUM ET DE TRYPTANOSOMA BRUCEI SUR LES RESERVES DE SPERME DE L’EPIDIDYME ET DES TESTICULES DES SOURIS

Résumé

Le trypanosome, un parasite des animaux domestiques et sauvages véhiculé par le sang, a été associé à la dégénérescence testiculaire.

L’objet de la présente étude était donc d’évaluer les effets de l’acéturate de diminazène, du chlorure d’isométamidium et de Trypanosoma brucei sur les réserves de sperme de l’épididyme et des testicules des souris.

Soixante souris mâles réparties en deux grands groupes étaient utilisées pour cette étude. Le groupe I était composé de souris infectées avec Trypanosoma brucei non- traitées ou de souris infectées avec un trypanosome et traitées avec deux doses différentes, soit avec l’acéturate de diminazène soit avec le chlorure d’isométamidium (T1 – T4). Le groupe II comprenait des souris non-infectées qui étaient soit non-infectées et non-traitées soit non-infectées mais traitées avec deux doses différentes, soit avec l’acéturate de diminazène soit avec le chlorure d’isométamidium. Dans l’ensemble, il y avait dix sous-groupes sous traitement.

Trois souris par groupe sous traitement étaient tuées à chaque période d’abattage. Pour les souris infectées et non-traitées, les périodes d’abattage étaient les jours 17 et 35. Les souris traitées à l’acéturate de diminazène à raison de 3,5 mg/kg de poids vif et 7 mg/kg de poids vif étaient aussi tuées les jours 17 et 35 respectivement. Les souris traitées au chlorure d’isométamidium à la dose de 1 mg/kg de poids vif et 2 mg/kg de poids vif étaient tuées après 35 jours et 70 jours respectivement. Les poids des testicules et de l’épididyme (la tête, le corps et la queue) étaient relevés à l’aide d’une balance sensible. Les réserves de sperme des testicules et de l’épididyme (les diverses parties de l’épididyme) étaient déterminées par la méthode hémocytométrique.

L’analyse de la variance (ANOVA) et le nouveau Test à variations multiples de Duncam (DNMRT) étaient utilisés pour l’analyse statistique des données.

Il y avait une baisse significative (P < 0,01) des réserves de sperme gonadique et extra-gonadique chez les souris du groupe I comparé à celles du groupe II. Le chlorure d’isométamidium à raison de 2 mg/kg de poids vif a considérablement diminué (P < 0,01) la réserve de sperme de l’épididyme. L’acéturate de diminazène à la dose de 7 mg/kg de poids vif a beaucoup réduit (P < 0,01) la réserve de sperme de la queue épididymale.

* Corresponding Author.
**Summary**

Trypanosomes, blood borne parasites of domestic and wild animals have been associated with testicular degeneration. This study was therefore designed to assess the effects of diminazene aceturate, isometamidium chloride and *Trypanosoma brucei* on epididymal and testicular sperm reserves if mice. Sixty (60) male mice divided into two broad groups were used in this study. Group I consisted of mice infected with *Trypanosoma brucei* that were untreated or trypanosome infected mice treated at 2 dose levels with either Diminazene aceturate (DA) or Isometamidium chloride (ISM) (T$_2$-T$_5$). Group II had uninfected mice that were either uninfected and untreated (T$_1$) or uninfected but treated at 2 levels (doses) with either Diminazene aceturate or Isometamidium chloride (T$_7$-T$_{10}$). On the whole, there were ten treatment groups.

Three mice per treatment group were sacrificed at every slaughter period. For the infected mice that were not treated, the slaughter periods were 17 and 35 days. Mice that received 3.5mg/kg body weight and 7.0mg/kg body weight of diminazene aceturate treatment were also sacrificed after 17 and 35 days respectively. Those mice that received isometamidium chloride treatment at 1.0mg/kg body weight and 2.0mg/kg body weight were sacrificed after 35 days and 70 days respectively.

Testes and epididymides (caput, corpus and cauda) weights were determined with a sensitive meter balance. Testicular and epididymal sperm reserves (various sections of the epididymides) were determined by haemocytometric method.

Analysis of variance (ANOVA) and Duncan’s New Multiple Range Test (DNMRT) were employed in the statistical analysis of the data. There were significant reduction (P < 0.01) in the gonadal and extragonadal sperm reserves of group I mice when it was compared with group II mice. Isometamidium chloride at 2.0mg/kg body weight significantly (P < 0.01) reduced the epididymal sperm reserve. Diminazene aceturate at 7.0mg/kg body weight significantly (P < 0.01) reduced the cauda epididymal sperm reserve.

**Introduction**

Trypanocides like diminazene aceturate, isometamidium chloride and homidium are commonly used by veterinarians and allied workers in the management/treatment of animal trypanosomosis, a disease that has remained a scourge in developing nations where domestic stock play a key role in subsistence and small-scale agriculture, the economic backbone of many of these nations.

Trypanocidal activity, mechanism of action and toxicity of these trypanocides have been investigated$^{1,2,3,4,5,6}$, Despite the results obtained by these workers, there is still a dearth of information on the effect some of these routine clinical drugs, especially diminazene aceturate and isometamidium chloride, could have on male fertility.

The present study was designed to assess the effects of diminazene aceturate,
isometamidium chloride and *Trypanosoma brucei* on epididymal and testicular sperm reserves of mice.

**Materials and Methods**

**Laboratory Animals**

A total of sixty (60) mature male mice weighing between 20 and 35 grams were used for this study. These mice were procured from the Faculty of Veterinary Medicine, University of Nigeria, Nsukka. All mice were kept in groups of 6 in stainless steel wire mesh cages at an ambient temperature of 27°C - 32°C. They were fed *ad libitum* with a commercial feed (Guinea Feed®, Nigeria). Mice were allowed preliminary adjustment period of one week prior to the commencement of the experiment.

**Parasite**

*T. brucei* (Tb/CT/19/P; 1995) used for this study was obtained from the National Veterinary Research Institute Vom, Plateau State, Nigeria. The trypanosomes had gone through two syringe serial passage in the same breed of mice as those used for this study. The prepatent period of this strain is 4-5 days. Infection of experimental mice was by intraperitoneal inoculation (1/ p) of blood diluted with normal saline (0.9%). The blood was obtained by making a snip with a sterile scissor off the tail tip of the parasitemic mice. Each of the infected experimental mice received 1 x 10^3 trypanosomes. The essence of this dose was to establish a prolonged period of infection.

**Diminazene aceturate**

This trypanocide used for this work was from Hoechst Ireland limited, Pharmaceutical Division, Cookstown Tallygaht, Dublin 24. The concentration of the drug used throughout the experiment was 1.7mg/ml.

**Isometamidium chloride**

This trypanocide was from May and Baker Ltd Dayenhen, England. The concentration of this drug, used throughout the study was 1mg/ml.

**Experimental protocol**

Mice were divided into 2 groups such that they were either infected with the trypanosome (Group I) or uninfected (Group II). Mice in group I were treated at 2 levels with either of the two drugs (T_2, T_3, T_4, & T_5). Control mice (T_1) were infected but untreated. Group II mice were treated at 2 levels with either of the two drugs (T_7, T_8, T_9 and T_10). Control mice (T_6) were uninfected and untreated. Thus there were a total of ten treatments as follows: T_1, T_5 (group I) and T_6 T_10 (group II).

Mice in T_2-T_5 received their respective treatments of diminazene aceturate and isometamidium chloride when parasitemia was established using the "Rapid Matching Method"^7. 

**Slaughter intervals**

This difference between drugs. Mice treated with D. A were slaughtered (3 per treatment) after 17 and 35 days while those mice that were treated with I. S. M. (3 per treatment) after 35 and 70 days. Isometamidium chloride lasts in the body system for about three months while diminazene aceturate stays for a period of 24 hours hence the difference in slaughter interval was to allow enough time for any changes in spermatogenesis to manifest. At slaughter, testes and epididymides (caput, corpus and cauda) were carefully removed, trimmed free of extraneous tissue and
weighed. A small portion of the testes (both sides B right and left) was removed, weighed and used for testicular sperm reserve determination. The small chunks of testes (right and left) were chopped separately into small pieces and homogenized in a solution containing 1ml of 0.09% NaCl and 0.05% Triton X-100 mixed before testicular sperm reserve could be determined by haemocytometric method. Similarly, the combined left and right portions of the epididymides (caput, corpus, and cauda) already weighed were chopped separately into pieces and homogenized in a solution containing 1ml of 0.09% NaCl and 0.05% Triton X-100 and used to determine the epididymal sperm reserve by the standard haemocytometric method. Triton X-100 was used in order to free sperm cells of particulate matter for better microscopic visibility.

**Statistical analysis**

Means and standard error of the means were calculated for each treatment group. Analysis of variance (ANOVA) using F ratio was employed to examine whether the differences observed in the parameters determined between the ten treatment groups were statistically significant. Following ANOVA, Duncan’s New Multiple Range Test (DNMRT) was used to separate the means that were statistically different.

**Results**

**Gonadal sperm reserve**

Figure 1 shows the effects of graded levels of diminazene aceturate, isometamidium chloride and trypanosome infection on the gonadal sperm reserve.

Comparative analysis of the data shows that mean gonadal sperm reserve for infected, untreated mice (T₀) was significantly lower (P < 0.01) than the mean gonadal sperm reserve for the uninfected, untreated one (control, T₀). The mean gonadal sperm reserves of the infected, treated mice (T₂-T₅) were significantly lower (P < 0.01) than that of the uninfected, untreated (T₀). There was no significant difference (P > 0.01) between the mean gonadal sperm reserve of the infected, untreated (T₀) and the infected, treated (T₂-T₅) mice. When the mean gonadal sperm reserves for the uninfected, treated mice (T₇-T₁₀) was compared with the mean gonadal sperm reserve of the uninfected, untreated (control T₀), it was found that there was no significant difference (P > 0.01) between their mean sperm reserves. Comparison of the mean gonadal sperm reserves of the infected, treated mice (T₂-T₅) with that of the uninfected, treated (T₇-T₁₀) showed that there was a significant decrease (P < 0.01) in the mean of T₂-T₅ (infected, treated).

**Extra-gonadal sperm reserves**

Figures 2, 3 and 4 show effects of graded levels of diminazene aceturate, isometamidium chloride and trypanosome infection on the sperm reserves of the three parts of the epididymides.

**Caput-epididymal sperm reserve**

Comparison of the mean caput-epididymal sperm reserve of the infected, untreated mice (T₀) with that of the uninfected, untreated (control, T₀) showed a significant decrease (P < 0.01) in the mean caput epididymal sperm reserve of T₀. Treatment of infected mice with diminazene aceturate and isometamidium chloride (T₂-T₅) gave mean caput-epididymal sperm reserves significantly lower (P < 0.01) than that of the control mice (T₀). However, the mean caput-epididymal sperm reserves of the infected mice treated with diminazene
aceturate $T_2$-$T_3$) was significantly higher ($P < 0.01$) than that of the infected, untreated ($T_4$) but there was no significant difference ($P > 0.01$) between the mean caput-epididymal sperm reserves of the infected, untreated ($T_4$) and infected mice treated with isometamidium chloride ($T_4$-$T_8$). When the mean caput-epididymal sperm reserve of the uninfected, treated mice ($T_7$-$T_{10}$) was compared with that of the infected, untreated (control, $T_6$), it was found that the caput-epididymal sperm reserve was significantly reduced ($P < 0.01$) only in the uninfected mice treated with 2.0mg/kg body weight of isometamidium chloride ($T_{10}$). Comparison of the mean caput-epididymal sperm reserves of the infected, treated mice ($T_4$-$T_3$) with that of the uninfected, treated ($T_7$-$T_{10}$) showed that uninfected mice treated with 2.0mg/kg body weight of isometamidium chloride had mean caput-epididymal sperm reserve which did not differ significantly ($P > 0.01$) with those of $T_2$, $T_3$ and $T_9$ but was significantly higher ($P > 0.01$) than the mean reserves of the infected, treated mice in $T_4$ and $T_5$ as well as being significantly lower ($P < 0.01$) than in $T_7$ and $T_8$.5
Corpus-epididymal sperm reserve

Comparison of the mean corpus-epididymal sperm reserve of the infected, untreated mice (T₁) with that of the uninfected, untreated (control T₆) showed a significant decrease (P < 0.01) in the mean corpus-epididymal sperm reserve of T₁. Treatment of infected mice with diminazene aceturate and isometamidium chloride (T₂-T₅) gave mean corpus-epididymal sperm reserves significantly lower (P < 0.01) than that of the control mice (T₆). Nonetheless, there was no significant difference (P > 0.01) between the mean corpus-epididymal sperm reserves of the infected, untreated (T₁) and the infected, treated (T₂-T₅) mice. When the mean corpus-epididymal sperm reserves of the uninfected, treated mice (T₇-T₁₀) was compared with the mean corpus-epididymal sperm reserve of uninfected, untreated (control, T₆), it was found that the corpus-epididymal sperm reserve was significantly reduced (P < 0.01) only in the uninfected mice treated with 2.0mg/kg body weight of isometamidium chloride (T₁₀).

Comparison of the mean corpus-epididymal sperm reserves of the infected, treated mice (T₂-T₅) with the mean corpus-epididymal sperm reserves of the uninfected, treated (T₇-T₁₀) showed that uninfected mice treated with isometamidium chloride at 2.0mg/kg body weight had mean corpus-epididymal
Fig. 3: Effects of graded levels of Diminazene aceturate (DA), Isometamidium chloride (ISM) and Trypanosoma brucei on epididymal and testicular sperm reserves of mice.

T1 - T1 - Infected, untreated
T2 - T2 - Infected, treated (3.5 mg/kg D.A)
T3 - T3 - Infected, treated (7.0 mg/kg D.A)
T4 - T4 - Infected, treated (1.0 mg/kg ISM)
T5 - T5 - Infected, treated (2.0 mg/kg ISM)
T6 - T6 - Uninfected, untreated
T7 - T7 - Uninfected, treated (3.5 mg/kg D.A)
T8 - T8 - Uninfected, treated (7.0 mg/kg D.A)
T9 - T9 - Uninfected, treated (1.0 mg/kg ISM)
T10 - T10 - Uninfected, treated (2.0 mg/kg ISM)

Fig. 4: Effects of graded levels of diminazene aceturate (DA), isometamidium chloride (ISM) and trypanosoma infection on cauda-epididymal sperm reserve

T1 - T1 - Infected, untreated
T2 - T2 - Infected, treated (3.5 mg/kg D.A)
T3 - T3 - Infected, treated (7.0 mg/kg D.A)
T4 - T4 - Infected, treated (1.0 mg/kg ISM)
T5 - T5 - Infected, treated (2.0 mg/kg ISM)
T6 - T6 - Uninfected, untreated
T7 - T7 - Uninfected, treated (3.5 mg/kg D.A)
T8 - T8 - Uninfected, treated (7.0 mg/kg D.A)
T9 - T9 - Uninfected, treated (1.0 mg/kg ISM)
T10 - T10 - Uninfected, treated (2.0 mg/kg ISM)
reserve significantly higher (P < 0.01) than the infected, treated mice in T₂ and T₅. There was no significant difference (P > 0.01) between the mean corpus-epididymal sperm reserve of the uninfected mice treated with isometamidium chloride at 2.0mg/kg body weight (T₁₀) and also the mean corpus-epididymal sperm reserve of T₃ and T₅ (infected, treated) and T₇ and T₉ (uninfected, treated).

**Cauda-epididymal sperm reserve**

Comparison of the mean cauda-epididymal sperm reserve of the infected, untreated mice (T₁) with that of the uninfected, untreated (control T₀) showed a significant decrease (P < 0.01) in the mean cauda-epididymal sperm reserve of T₁. Treatment of infected mice with diminazene aceturate and isometamidium chloride (T₂-T₅) gave mean cauda-epididymal sperm reserve significantly lower (P < 0.01) than that of the control mice (T₀). However, there was no significant difference (P > 0.01) between the mean cauda-epididymal sperm reserves of the infected, untreated (T₁) and infected, treated (T₂-T₅) mice. When the mean cauda-epididymal sperm reserve of the uninfected, treated mice (T₇-T₁₀) was compared with the mean caudal-epididymal sperm reserve of the uninfected, untreated (control, T₀), it was found that the cauda-epididymal sperm reserve was significantly reduced (P < 0.01) only in the uninfected mice treated with 2.0mg/kg body weight of isometamidium chloride (T₁₀).

When the mean cauda-epididymal sperm reserve of the infected, treated mice (T₂-T₅) were compared with that of uninfected, treated (T₇-T₁₀), there was significant reduction (P < 0.01) in the mean caudal epididymal sperm reserve of T₂-T₅ over that of T₇-T₁₀ except the mean cauda-

epididymal sperm reserve of uninfected mice treated with isometamidium chloride at 2.0mg/kg body weight which did not differ significantly (P > 0.01) from that of T₂-T₅.

**Discussion**

The results of this study have shown that there was a significant reduction (P < 0.01) in the gonadal sperm reserve of mice infected with *Trypanosoma brucei*. Ikede and Akpavie¹⁰ reported similar findings following experimental infection of *T. brucei* in the rabbit. Kaaya¹¹ and Kaaya and Odur-Okelo ¹² had reported aspermato genesis and progressive fibrosis in goats infected with *T. congolense*.

However, treating infected mice with the two trypanocides at their respective two dosage levels did not significantly alter the reduction in gonadal sperm reserve following infection. It can be drawn from this study that infection of mice with trypanosomes causes significant reduction in spermatogenesis which drug (diminazene aceturate and isometamidium chloride) treatment was not able to reverse immediately. This observation was in line with that of Ikede and Akpavie ¹¹ who reported that normal seminiferous tubules were not fully restored one hundred and forty-nine days (149 days) after rabbits infected with *T. brucei* were treated with diminazene aceturate.

The total extragonadal sperm was reduced in the present study following infection of mice with *T. brucei*. This observation indicates that trypanosome infection significantly disrupted spermatogenesis which led to reduction in total extragonadal sperm reserve. Treating infected mice with diminazene aceturate at 3.5mg/kg and 7.0mg/kg body weight significantly (P < 0.01) elevated the caput-
epididymal sperm reserve following infection. Such a significant improvement on the caput-epididymal sperm reserve in the infected, diminazene aceturate treated mice probably suggests that this drug at both low and high levels was able to reduce the damage the trypanosomes were inflicting on the testes following testicular invasion. The administration of isometamidium chloride at 2.0mg/kg body weight to uninfected mice significantly (P < 0.01) reduced the sperm reserves of the various parts of the epididymis. It is possible that treating resistant cases of trypanosome infection of farm animals with this dosage of isometamidium chloride can alter the transit time of the epididymal spermatozoa which may lead to increased resorption of sperm cells and subsequent decrease in the epididymal sperm reserves.

The cauda-epididymal sperm reserve was significantly reduced (P < 0.01) in the uninfected mice treated with 7.0mg/kg body weight of diminazene aceturate. Mature sperm cells are stored in the cauda-epididymis and the use of diminazene aceturate at 7.0mg/kg in treating infected livestock/farm animals may alter the number of spermatozoa stored in this section of the epididymis.

The reduction in the number of spermatozoa in the various parts of the epididymides which was evident in infected mice may be associated with the release of toxic cytokines encountered in the disease. Cytokines such as tumour necrosis factor, gamma interferon and interleukines are released by macrophages that have been activated by infection. In healthy animals, cytokines function as modulators of the immune system, even though they may have toxic effects on cells of the animals.

The functions of the epididymis include sperm reabsorption and storage. It is not clear from this study whether the depression in the number of spermatozoa observed in the various parts of the epididymis in the infected, untreated (T1), infected, treated (T2-T6), uninfected, diminazene aceturate treated at 7.0mg/kg body weight (T7) and uninfected, isometamidium chloride treated at 2.0mg/kg body weight (T8) mice was due to increased reabsorption and/or loss of spermatozoa or increased phagocytic agents as a result of infection or drug action. Further studies are needed to explain this.

This investigation has demonstrated that the use of diminazene aceturate at 3.5mg/kg body weight in the treatment of T. brucei infection in male mice did not affect spermatogenesis. However, there was a small but significant reduction (P < 0.01) (Duncan's Multiple Range Test) in the cauda-epididymal sperm reserve when diminazene aceturate was used at 7.0mg/kg body weight. Isometamidium chloride on the other hand, at 2.0mg/kg body weight significantly (P < 0.01) reduced the sperm reserves of the three parts of the epididymis.

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ANTIMICROBIAL RESISTANCE TO SALMONELLEAE ISOLATED FROM RETAIL RAW CHICKEN MEAT AND GIBLETS IN ETHIOPIA

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RESISTANCE ANTIMICROBIENNE AUX SALMONELLES ISOLEES DE LA VIANDE DE POULET CRUE VENDUE AU DETAIL ET DES ABATS DE VOLAILLE

Résumé

La présente étude a été menée en vue d'évaluer la résistance antimicrobienne des souches de Salmonella issues de la viande de poulet crue vendue au détail et des abats de volaille (gésier et foie) à Addis-Abeba en Ethiopie de février 2001 à septembre 2001. Au total, 301 échantillons (244 viandes de poulet, 32 gésiers et 25 foies) étaient collectés de 22 supermarchés choisis au hasard. Les salmonelles étaient isolées dans 54 (17,5%) des échantillons analysés. Neuf différents sérovars étaient identifiés, parmi lesquels les plus prévalents étaient : Salmonella braenderup (31,5%) ; S. anatum (25,9%) ; S. saintpaul (14,8%) et S. uganda. Toutes les souches de Salmonella étaient examinées afin de déterminer la résistance antimicrobienne à un groupe de 17 antimicroorganismes choisis. Trente-et-une (54,8%) des souches de Salmonella étaient résistantes à un antimicroorganisme ou plus. Le degré de résistance aux souches de Salmonella issues des échantillons de viande de poulet, de gésier et de foie était de 60% ; 47,1% et 71,4% respectivement. Environ 58,8% ; 50% ; 35,7% et 33,3% de Salmonella braenderup, S. saintpaul, S. anatum et S. uganda étaient respectivement résistantes à l’un des antimicroorganismes ou plus testés. Sur les 31 souches de Salmonella résistantes, 17 (54,8%) montraient une résistance multiple à six différents antimicroorganismes (ampicilline, streptomycine, triméthoprim, sulfaméthoxazole, triméthoprim-sulfaméthoxazole et spectinomycine). Les résultats de l'étude ont montré l'importance de la viande de poulet et des abats de volaille en tant que sources de souches de salmonella avec une résistance simple et multiple aux différents antimicroorganismes en Ethiopie.

Summary

This study was undertaken to estimate the antimicrobial resistance of Salmonella isolates from retail raw chicken meat and giblets (gizzard and liver) in Addis Ababa, Ethiopia from February 2001–September 2001. A total of 301 samples (244 chicken meat, 32 gizzards and 25 livers) were collected from 22 randomly selected supermarkets. Salmonellae were isolated in 54 (17.5%) of the samples analysed. Nine different serovars were identified of which the most prevalent were Salmonella braenderup (31.5%), S. anatum (25.9%), S. saintpaul (14.8%) and S. uganda. All Salmonella isolates were examined for antimicrobial resistance to a group of 17 selected antimicrobials. Thirty-one (54.8%) Salmonella isolates were resistant to one or more antimicrobials. The level of resistance of Salmonella isolates from chicken meat, gizzard and liver samples were 60.0%, 47.1% and 71.4% respectively. Approximately 58.8%, 50%, 35.7% and 33.3% of Salmonella braenderup, S. saintpaul, S. anatum and S. uganda respectively were resistant to one or more of the antimicrobials tested. Out of 31 resistant Salmonella isolates, 17 (54.8%) exhibited multiple resistance to up to 6 different antimicrobials (ampicillin, streptomycin, trimethoprim, sulfamethoxazole, trimethoprim-sulfamethoxazole and spectinomycin). The results of the study showed the significance of chicken meat and giblets as sources of single and multiple resistant Salmonella strains to different antimicrobials in Ethiopia.

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Introduction

Antimicrobial resistant pathogens develop and are usually associated with the wide use of drugs in medicated feed, administration of subtherapeutic doses of antimicrobials in the treatment of animals and humans against bacterial pathogens. Foods of animal origin including poultry and poultry products harbouring antimicrobial resistant Salmonella present a high level of human health risk as the systemic spread of these pathogens could result in serious complications in humans. This is particularly more severe and could lead to a fatal outcome for the high-risk part of the populations including infants, elderly, immunocompromised and malnourished individuals. In addition to the wide spread of Salmonella infections in many animal species and humans, there is also an increase in Salmonella resistance to commonly used antimicrobials, both in public health and veterinary sectors worldwide.

It is reported that exposure of food animals including poultry to the use of subtherapeutic doses of antibiotics for prophylaxis or for growth promotion potentiates the occurrence and distribution of resistant salmonellae in meat and meat products. This will in turn increase the risk of both human salmonellosis and infections with antibiotic resistant Salmonella strains of animal origin. The evolution of Salmonella strains resistant to commonly used antimicrobials has made infections with Salmonella in food animals difficult to control and will likely remain an animal health problem for quite some time specially in countries where there is lack of a coordinated epidemiological surveillance and reporting systems for salmonellosis and other foodborne diseases. The current literature suggests that the presence and increase of antibiotic resistant Salmonella in foods is a serious public health problem.

The issue of antimicrobial resistance becomes more difficult and complex particularly in developing countries. This is because salmonellae and other pathogenic bacteria of veterinary and public health significance are not routinely cultured and their resistance to commonly used antimicrobials both in human and veterinary practices are rarely determined. Studies on antimicrobial resistant salmonellae are usually undertaken to monitor and improve husbandry and management practices and to ensure the production of feeds and foods free of antimicrobials and drug-resistant Salmonella to protect the health of the consumers and promote the international trade of animals and animal products.

The purpose of the present study was to estimate the frequency and pattern of antimicrobial resistant Salmonella isolates from retail raw chicken meat and giblets in Addis Ababa (Ethiopia).

Materials and methods

Sample collection

A total of 301 retail raw chicken samples (244 chicken meat, 32 gizzards, and 25 livers) were collected from 22 randomly selected supermarkets in Addis Ababa, Ethiopia. A simple random selection of supermarkets was used to generate a sequence of random numbers from a coded list of supermarkets (n = 41). Whole chicken carcasses and giblets (liver and gizzard) were again randomly selected and purchased from the identified supermarkets. The samples were either fresh or frozen. The study involved a once weekly visit of sampling premises and collection of samples from February 2001.
to September 2001. The samples were packed in iceboxes and transported immediately to the Microbiology Laboratory of the Faculty of Veterinary Medicine, Addis Ababa University, Debre Zeit, Ethiopia for analysis.

**Isolation and identification of Salmonella**

Salmonellae were isolated and identified following the technique recommended by the International Organization for Standardization: ISO 6579\(^4\). Briefly, frozen samples were thawed at room temperature for about 3-5 hours. Twenty-five grams of each sample (chicken meat, gizzard and liver) were excised using a sterile scalpel. Each was weighed and put into a sterile stomacher bag containing 225 ml of buffered peptone water (Merck, Germany). For the whole chicken, the 25 g were made of samples of breast, wing, thigh, neck and back skin and muscles taken from multiple points on the carcasses. The samples were then mixed for 2 minutes using a stomacher (Seward Stomacher 400, England) and incubated at 37°C for 16 to 20 h. After incubation, 0.1 ml of the pre-enriched sample was transferred into 10 ml of Rappaport-Vassiliadis broth (Merck, Germany) and incubated at 42°C for 18 to 24 h. Another 1 ml was transferred into 10 ml of selenite cystine broth (SIFINØ, Berlin) and incubated at 37°C for 18 to 24 h. Following incubation, a loopful of each culture was streaked onto brilliant green phenol-red lactose-sucrose (BPLS) and xylose lysine deoxycholate (XLD) agar plates (Merck, Germany) which were incubated at 37°C for 18 to 24 h. If no typical colonies were present or the growth was slight, the plates were re-incubated at the same temperature and duration. Presumptive *Salmonella* colonies chosen from each plate were inoculated onto nutrient agar (Merck, Germany) and grown overnight at 37°C.

*Salmonella* isolates were screened biochemically using triple sugar iron agar, citrate, lysine decarboxylase, urease test, indole and Voges-Proskauer reaction tests. Colonies that exhibited typical reactions were further characterized biochemically using BBL\(^{®}\) Enterotube™ II (Roche, Diagnostica, Basel, Switzerland) as recommended by the manufacturer. Suspected colonies were screened by the slide agglutination test using *Salmonella* polyvalent O antiserum I and II (SIFINØ, Berlin). The isolates, which tested positive for *Salmonella*, were sub-cultured on brain heart infusion agar (Merck, Germany) and sent to Berlin (Germany). Serotyping and antimicrobial resistance testing of the *Salmonella* isolates was done at the National *Salmonella* Reference Laboratory of the Federal Institute for Health Protection of Consumers and Veterinary Medicine (BgVV), Berlin, Germany.

**Antimicrobial resistance test**

The antimicrobial resistance of *Salmonella* isolates was estimated with the minimal inhibition concentration (MIC) technique at (BgVV), Germany. The tests were performed following the recommendations of the National Committee for Clinical Laboratory Standards, NCCLS\(^5\), USA. Performance standards for antimicrobial disk and dilution susceptibility tests for bacteria isolated from animals (M31-A) were used. Antimicrobial susceptibility testing was performed by a micro dilution broth method\(^15\) and ready prepared
microtitre plates from TREK Diagnostic Systems LTD, England, were used. Breakpoints suggested by NCCLS were employed. Table 1 shows the type of antimicrobials, abbreviations and concentrations of each drug used in the present study. The concentration of the antimicrobial agents and the interpretation of the strains as susceptible, intermediate and resistant followed the recommendations of the National Committee for Clinical Laboratory Standards. An isolate was defined as resistant if it was resistant to one or more of the antimicrobial agents tested whereas multiple resistance was defined as resistance to 2 or more antimicrobial agents.

**Results**

Salmonellae were isolated from 54 (17.9 %) of the 301 chicken meat and giblet samples collected from supermarkets in Addis Ababa, Ethiopia (Table 2). The *Salmonella* contamination level was high in chicken giblets compared to chicken meat, which were respectively 12.3 % (30/244), 53.1 % (17/32) and 28.0 % (7/25) in chicken meat, gizzards and livers respectively. Out of the 54 *Salmonella* isolates, nine different serovars were identified of which *Salmonella braenderup* (31.5 %), *S. anatum* (25.9 %), *S. saintpaul* (14.8 %), and *S. uganda* were the most prevalent ones.

Of the total 54 *Salmonella* isolates, 31 (57.4 %) were resistant to one or more antimicrobials (Table 2). The level of antimicrobial resistance from chicken meat, gizzard and liver samples were 60.0 %, 47.1 % and 71.4 % respectively.

Of the 17 antimicrobials tested in our study 7 (41.2 %) (ampicillin, spectinomycin, streptomycin, tetracycline, sulphamethoxazole, trimethoprim and trimethoprim-sulphamethoxazole) were not effective against the *Salmonella* isolated from chicken meat and giblets in the study area.

Table 3 shows the multiple resistance patterns of *Salmonella* isolates from chicken meat and giblets. Among the 31 resistant *Salmonella* isolates, 17 (54.8 %) showed a multiple resistance pattern (resistance to two or more antimicrobials).

All resistant isolates of *S. anatum* and *S. saintpaul* were multiple resistant (100 %), followed by *S. braenderup* and *S. rough* form (50.0 % each) and *S. uganda* (25.0 %). *Salmonella braenderup*, *S. anatum* and *S. saintpaul* showed multiple resistance to up to 6 different antimicrobials (ampicillin, streptomycin, trimethoprim, spectinomycin, trimethoprim-sulphamethoxazole, sulphamethoxazole and tetracycline). (Table 3).

**Discussion**

The level of contamination of chicken meat and giblets with *Salmonella* observed in this study was high. Our results were comparable with those reported in some African countries and other parts of the world. Chicken giblets in supermarkets showed a relatively higher level of *Salmonella* contamination than chicken meat.

A high frequency of antimicrobial resistance to *Salmonella* serovars was observed in the present study against selected antimicrobials and were in agreement with other reports on drug resistance among *Salmonella* species isolated from poultry meat and from other avian sources. The single and multiple resistance observed in the present study was with those antimicrobials commonly employed in veterinary and public health practices and particularly to
### Table 1: Antimicrobials used, abbreviations, concentrations and breakpoints

<table>
<thead>
<tr>
<th>Antimicrobial Agent</th>
<th>Abbreviation</th>
<th>Concentrations tested (µg/ml)</th>
<th>Breakpoints (µg/ml)</th>
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<tbody>
<tr>
<td>Ampicillin</td>
<td>AMP</td>
<td>1-32</td>
<td>&lt;16</td>
</tr>
<tr>
<td>Amoxicillin/Clavulanic acid</td>
<td>AUG2</td>
<td>2/1-32/16</td>
<td>&lt;16/8</td>
</tr>
<tr>
<td>Ceftiofur</td>
<td>XNL</td>
<td>0.5-8.0</td>
<td>&lt;4.0</td>
</tr>
<tr>
<td>Chloramphenicol</td>
<td>CHL</td>
<td>2-64</td>
<td>&lt;16</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>CIP</td>
<td>0.03-4.0</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>Colistin</td>
<td>COL</td>
<td>4-64</td>
<td>≥8</td>
</tr>
<tr>
<td>Florfenicol</td>
<td>FFN</td>
<td>2-64</td>
<td>&lt;16</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>GEN</td>
<td>1-32</td>
<td>&lt;8</td>
</tr>
<tr>
<td>Kanamycin</td>
<td>KAN</td>
<td>4-64</td>
<td>&lt;32</td>
</tr>
<tr>
<td>Nalidixic acid</td>
<td>NAL</td>
<td>4-128</td>
<td>≥16</td>
</tr>
<tr>
<td>Neomycin</td>
<td>NEO</td>
<td>2-32</td>
<td>&lt;8</td>
</tr>
<tr>
<td>Sulfamethoxazole</td>
<td>SMX</td>
<td>32-512</td>
<td>≥256</td>
</tr>
<tr>
<td>Spectinomycin</td>
<td>SPE</td>
<td>2-128</td>
<td>≥64</td>
</tr>
<tr>
<td>Streptomycin</td>
<td>STR</td>
<td>4-64</td>
<td>&lt;16</td>
</tr>
<tr>
<td>Trimethoprim/Sulfamethoxazole</td>
<td>SXT</td>
<td>1/19-8/152</td>
<td>≥2/38</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>TET</td>
<td>2-32</td>
<td>&lt;8</td>
</tr>
<tr>
<td>Trimethoprim</td>
<td>TMP</td>
<td>4-32</td>
<td>≥8</td>
</tr>
</tbody>
</table>
Table 2: Distribution of antimicrobial-resistant *Salmonella* isolates by source.

<table>
<thead>
<tr>
<th>Sample type</th>
<th>Number of samples</th>
<th>Number of resistant isolates (%)</th>
<th>Serotype</th>
<th>No. of serovars</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Examined</td>
<td>Positive (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicken meat</td>
<td>244</td>
<td>30 (12.3)</td>
<td>S. <em>braenderup</em></td>
<td>7 (23.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S. <em>anatum</em></td>
<td>6 (20.0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S. <em>uganda</em></td>
<td>5 (16.7)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S. <em>saintpaul</em></td>
<td>4 (13.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S. <em>haifa</em></td>
<td>2 (6.7)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S. <em>typhimurium</em></td>
<td>2 (6.7)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S. <em>virchow</em></td>
<td>1 (3.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S. <em>rough form</em></td>
<td>2 (6.7)</td>
</tr>
<tr>
<td>Gizzard</td>
<td>32</td>
<td>17 (53.2)</td>
<td>S. <em>braenderup</em></td>
<td>6 (35.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S. <em>anatum</em></td>
<td>6 (35.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S. <em>saintpaul</em></td>
<td>3 (17.6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S. <em>uganda</em></td>
<td>1 (5.9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S. (group B)</td>
<td>1 (5.9)</td>
</tr>
<tr>
<td>Liver</td>
<td>25</td>
<td>7 (28.0)</td>
<td>S. <em>braenderup</em></td>
<td>4 (57.1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S. <em>anatum</em></td>
<td>2 (28.6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S. <em>saintpaul</em></td>
<td>1 (14.3)</td>
</tr>
<tr>
<td>Total</td>
<td>301</td>
<td>54 (17.9)</td>
<td>54</td>
<td>31 (57.4)</td>
</tr>
</tbody>
</table>

* Number of serovars intermediately resistant
sulphamethoxazole, trimethoprim, tetracycline, trimethoprim-sulphamethoxazole, streptomycin and ampicillin which are also used for the treatment of different bacterial diseases of humans in Ethiopia.

The increased antimicrobial resistance of Salmonella isolates to different drugs could be attributed to the indiscriminate and continuous use of subtherapeutic doses of antimicrobials in animals especially in chicken production. Some of the antimicrobial agents employed in the present study are also used in raising broilers. Furazolidone and tetracyclines are used to promote growth of chicken in intensive poultry farms. The widespread use of medicated feeds in intensively managed poultry could contribute substantially to the establishment and spread of resistant Salmonella strains within the animal population and their meat and meat products. Salmonella strains isolated from various foods of animal origin and humans in different countries of the world showed a high level of antimicrobial resistance.

The results of the present study support the well-established fact that antimicrobial resistance of Salmonella isolates in sub-Saharan Africa is generally high and is primarily attributed to the indiscriminate use of antimicrobials in animal and human health sectors. In a study of 45 Salmonella strains isolated from a total of 700 human diarrhoeal outpatients in Addis Ababa (Ethiopia), 71.1% of the isolates were resistant to tetracycline, 68.9% to ampicillin, 66.7% to cephalothin, 57.8% to sulphamethoxazole, 53.9% to kanamycin and 46.7% to chloramphenicol. However, in our study all Salmonella isolates were susceptible to chloramphenicol, kanamycin and gentamycin, which are also used routinely for the treatment of bacterial diseases in humans in Ethiopia. A study of antibiotic susceptibility testing in Malawi and Kenya indicated that 42% of 33 Salmonella isolates from humans were resistant and the most frequent resistant strains belonged to S. typhimurium and S. enteritidis. The use of antimicrobials as uncontrolled prophylaxis or as growth promoters in feed encourages not only the emergence and persistence of resistant strains but also increases infections of animals through intermittent and prolonged faecal shedding of Salmonella in the environment. Furthermore, it hampers the use of antibiotics in therapy both in veterinary and public health practices.

Besides the increasing resistance to commonly used antibiotics in animals and humans there is a concurrent increase in multiple resistant Salmonella isolates worldwide. In our study all S. saintpaul and S. anatum strains were multiple resistant, followed by S. braenderup (50.0%), Salmonella rough form (50.0%) and S. uganda (25.0%) showing resistance up to 6 different antimicrobials. Hadfield et al. isolated S. enteritidis having a multiple drug-resistance (to 4 antibiotics) from 100 paediatric patients in Liberia, West Africa. Nasinyama et al. detected S. typhimurium and S.enteritidis having multiple resistance (to 5 antibiotics) from humans in Kampala, Uganda. Various studies revealed the potential importance of poultry as a source of resistant Salmonella serovars for human infections and the need for a national surveillance system to monitor antimicrobial use and the occurrence and frequency of antimicrobial resistant Salmonella among food animals including poultry.
Table 3: Multiple resistance patterns of *Salmonella* isolates

<table>
<thead>
<tr>
<th>Serovar</th>
<th>Tested</th>
<th>Resistant</th>
<th>Multiple resistant</th>
<th>Antimicrobial type*</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>S. braenderup</em></td>
<td>17</td>
<td>10</td>
<td>5:</td>
<td></td>
<td>Liver</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>AMP, STR, SXT, SMX, SPE, TMP</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>STR, TMP, SMX, SPE</td>
<td>Gizzard</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>AMP, TMP, SMX</td>
<td>Gizzard</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>AMP, STR, STX, TMP, SMX, SPE</td>
<td>Liver</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>STR, TMP, SMX, SPE</td>
<td>Chicken meat</td>
</tr>
<tr>
<td><em>S. anatum</em></td>
<td>14</td>
<td>5</td>
<td>5:</td>
<td></td>
<td>Liver</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>TMP, SMX, TET, SXT</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>AMP, STR, TMP, SMX, SPE, SXT</td>
<td>Chicken meat</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>STR, SXT, TET, TMP, SMX, SPE</td>
<td>Chicken meat</td>
</tr>
<tr>
<td><em>S. saintpaul</em></td>
<td>8</td>
<td>4</td>
<td>4:</td>
<td></td>
<td>Liver</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>SXT, TMP, SMX, SPE</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>SXT, SMX, SPE, TMP</td>
<td>Gizzard</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>AMP, STR, TMP, SMX, SPE</td>
<td>Gizzard</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>AMP, SXT, TMP, SMX</td>
<td>Chicken meat</td>
</tr>
<tr>
<td><em>S. rough form</em></td>
<td>2</td>
<td>2</td>
<td></td>
<td>AMP, STR, SXT, TMP, SMX, SPE</td>
<td>Chicken meat</td>
</tr>
<tr>
<td><em>S. ugdana</em></td>
<td>6</td>
<td>4</td>
<td></td>
<td>AMP, TMP, SMX, SXT</td>
<td>Chicken meat</td>
</tr>
<tr>
<td><em>S. group B</em></td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>S. virchow</em></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>S. haifa</em></td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>S. typhimurium</em></td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>AMP, SMX</td>
<td>Chicken meat</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>54</strong></td>
<td><strong>31</strong></td>
<td><strong>17</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*For key of abbreviations see Table 1.*
Salmonella isolates in foods of animal origin seriously compromises public and animal health\(^1\), \(^2\), \(^4\), \(^25\). This requires special considerations particularly in those countries like Ethiopia where antimicrobials are indiscriminately used and their effectiveness against common human and animal bacterial pathogens is rarely evaluated. The results of the present study showed the significance of chicken meat and giblets as sources of single and multiple resistant Salmonella strains to different antimicrobials, which are also used in the public health sector for the treatment of clinical salmonellosis and other bacterial pathogens in Ethiopia.

Acknowledgements

The authors wish to thank Prof. Dr. R. Helmuth, Dr A. Schroeder and Dr C. Dorn (National Salmonella Reference Laboratory of the Federal Institute for Health Protection of Consumers and Veterinary Medicine (BfVV), Berlin) for serotyping and antimicrobial resistance testing of Salmonella isolates. This study was part of MSc thesis of Boniphace Tibajuka and was supported by the German Academic Exchange Service (DAAD) and German Technical Cooperation (GTZ).

References


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RESPONSE OF CATTLE TO DRY SEASON SUPPLEMENTATION OF UREA-AMMONIATED RICE STRAW OR UNTREATED RICE STRAW FED WITH GRIFFONIA SIMPLIFICIFOLIA OR WHEATBRAN

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Department of Animal Science, University of Ghana, Legon.

REACTION DES BOVINS A LA SUPPLEMENTATION PENDANT LA SAISON SECHE AVEC DE LA PAILLE DE RIZ TRAITEE A L'UREE AMMONIACALE OU AVEC DE LA PAILLE DE RIZ NON-TRAITEE SERVIE AVEC DU GRIFFONIA SIMPLIFICIFOLIA OU DU SON DE BLE

Résumé

Une expérience d'alimentation a été faite à la Station de recherche de Katamanso de l'Institut de recherche sur l'élevage en utilisant quatre paires de vaches et de veaux par traitement. Les traitements appliqués étaient les suivants : pâturage naturel uniquement (sujets-témoins) (régime 1); pâturage naturel et paille de riz traitée à l'urée ammoniacale (régime 2); pâturage naturel et paille de riz non-traitée supplémentées avec Griffonia simplicifolia (régime 3) et pâturage naturel et paille de riz non-traitée supplémentées avec du son de blé (régime 4). Les suppléments étaient servis aux animaux individuels des groupes soumis au test. Il n'y avait pas de différence significative (P>0,05) entre les régimes en termes de taux de croissance des vaches et des veaux (kg/jour⁻¹). Le régime 4 avait la plus importante consommation quotidienne de matière sèche (CQMS), à savoir : 775,4 g/jour⁻¹, ce qui était très différent (P<0,05) du régime 2 (460,3g jour⁻¹) et du régime 3 (319,4 g/jour⁻¹). On a noté un effet marquant du mois d'observation (P<0,01) ainsi qu'une interaction significative du traitement x mois d'observation sur la CQMS (P=0,01). Il y avait une augmentation globale de la consommation de matière sèche de paille de riz non-traitée était beaucoup plus grande (P<0,001) pour le régime 4 (361,8 g/jour⁻¹) comparé au régime 3 (132,4g/jour⁻¹) pendant tous les mois. Il a été conclu que l'alimentation avec de la paille de riz non-traitée supplémentée avec Griffonia simplicifolia soit avec du son de blé était comparable à l'alimentation avec de la paille de riz traitée à l'urée ammoniacale en tant que supplément alimentaire pour les bovins pendant la saison sèche. Cependant, afin de s'assurer que la consommation de matière sèche est assez grande pour permettre d'obtenir un changement notable de la production, il faudrait aussi peut-être servir des légumineuses et des sous-produits agro-industriels qu'elles paraîtraient complémentaires.

Summary

A feeding trial was carried out at the Katamanso Research Station of the Animal Research Institute using 4 cow and calf pairs per treatment. The treatments used were: Grazing on natural pasture only (control) (Diet 1), natural grazing plus urea-ammoniated rice straw (Diet 2), natural grazing plus untreated rice straw supplemented with Griffonia simplicifolia (Diet 3) and natural grazing plus untreated rice straw supplemented wheat bran (Diet 4). Supplements were fed to individual animals in the test groups. There was no significant difference (P>0.05) between diets in terms of cow and calf growth rate (kg day⁻¹). Diet 4 had the highest daily dry matter intake (DDMI) of 775.4 g day⁻¹ and this significantly different (P<0.05) from diet 2 (460.3 g day⁻¹) and diet 3 (319.4 g day⁻¹). There was a significant treatment X month of observation interaction (P<0.01) on DDMI. There was a general increase in dry matter intake from January to March for all treatments. Dry matter intake of untreated rice straw was significantly (P<0.001) higher in diet 4 (361.8 g day⁻¹) as compared to diet 3 (132.4 g day⁻¹) in all the months. It was concluded that the feeding of untreated rice straw with either Griffonia simplicifolia or wheat bran was comparable to feeding urea-ammoniated rice straw as as dry season feed supplement for cattle. To ensure a dry matter intake, high enough to cause an appreciable change in production, however, there may be need to feed both leguminous browse and agro-industrial by-products as they would appear to complement each other.

Introduction

Supplementation of poor quality tropical forages with foliage from multi-purpose trees of leguminous browse has been shown to improve growth rates in animals1,2,3,4,5. The foliage of these trees maintain their feeding value well into the dry season and are a rich source of nitrogen, minerals and vitamin A.

* Corresponding Author.
+ Deceased
Table 1. Proximate chemical composition of experimental feeds

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Untreated Rice straw</th>
<th>Urea-ammoniated rice straw</th>
<th>Griffonia simplicifolia</th>
<th>Wheat bran</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter (g Kg-1)</td>
<td>891</td>
<td>873</td>
<td>389</td>
<td>843</td>
</tr>
<tr>
<td>g Kg-1 DM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organic matter</td>
<td>818</td>
<td>801</td>
<td>888</td>
<td>944</td>
</tr>
<tr>
<td>NDF</td>
<td>775</td>
<td>721</td>
<td>534</td>
<td>441</td>
</tr>
<tr>
<td>ADF</td>
<td>584</td>
<td>624</td>
<td>330</td>
<td>125</td>
</tr>
<tr>
<td>ADL</td>
<td>67</td>
<td>58</td>
<td>149</td>
<td>37</td>
</tr>
<tr>
<td>Hemicellulose</td>
<td>191</td>
<td>97</td>
<td>204</td>
<td>316</td>
</tr>
<tr>
<td>Cellulose</td>
<td>403</td>
<td>445</td>
<td>195</td>
<td>89</td>
</tr>
<tr>
<td>Nitrogen X 6.</td>
<td>44.9</td>
<td>92.5</td>
<td>178.2</td>
<td>150.3</td>
</tr>
</tbody>
</table>

Table 2. Least square means of daily dry matter intake of untreated rice straw (grams) as affected by feeding wheat bran or Griffonia.

<table>
<thead>
<tr>
<th></th>
<th>CTRL</th>
<th>UTS</th>
<th>GRISTR</th>
<th>WBRSTR</th>
<th>SED</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min.</td>
<td>-</td>
<td>-</td>
<td>0.0</td>
<td>77.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max.</td>
<td>-</td>
<td>-</td>
<td>273.2</td>
<td>450.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>-</td>
<td>-</td>
<td>132.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>361.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>16.28</td>
<td>***</td>
</tr>
<tr>
<td>Daily dry matter intake of straw</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>January</td>
<td>-</td>
<td>-</td>
<td>75.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>47.71</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>February</td>
<td>-</td>
<td>-</td>
<td>131.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>436.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>35.19</td>
<td>***</td>
</tr>
<tr>
<td>March</td>
<td>-</td>
<td>-</td>
<td>255.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>447.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>17.57</td>
<td>***</td>
</tr>
</tbody>
</table>

CTRL - Control;
UTS - Urea ammoniated rice straw;
GRISTR - Griffonia plus untreated rice straw;
WBRSTR - Wheat bran plus untreated rice straw.

Means within a row postscripts are not significantly different (P>0.05).
precursors. The potential of local Ghanian browse plants as supplementary feeds to grazing, especially in the dry season has been observed. The feeding of various local browse plants with sodium hydroxide treated rice straw. Studies carried out in Ethiopia, in which untreated teff straw was fed with various multi-purpose tree leaves, also gave good results. This study was, therefore carried out to compare the feeding of urea-ammoniated rice straw with untreated rice straw supplemented with either *Griffonia simplicifolia* (local Ghanaian browse plant) or wheat bran.

**Materials and Methods**

**Cattle herd management**

The study was carried out between December, 1999 and March 2000 at the Animal Research Institute, Katamanso, using a Sanga Herd that is basically managed under a pastoral system. The Institute employs herdsmen who take the cattle out to graze. The herd leaves the station at about 9.00 am and returns at 4.00 pm. These grazing times are adhered to regardless of season. During the dry season, however, animals are usually fed a supplement of hay (*Bracchiaia spp*) on their return from grazing. Animals are milked once, in the morning, before they are taken out to graze. Dominant grass species in the grazing areas are *Panicum maximum*, *Sporobolus pyramidalis* and *Vertivera fulvibarbis*. Thickets with *Griffonia simplicifolia*, *Baphia nitida* and *Milletia thoningii* are also present. Cattle are watered from a dam with the animals drinking on their way to and from grazing. Natural mating is practised with service bulls running freely with females. Control of ectoparasites is by use of pour-on (Bayticol, Bayer, Germany) and this is done once every two months.

**Preparation of urea-ammoniated rice straw**

The treatment was done in a sheet of polysack material measuring 2.2 by 2.2 m and this could contain about 25kg of chopped rice straw. This was made by sewing together four (4) empty sacks used for bagging wheat bran after they had been cut open. The polysack was lined with a polythene sheet (1X1m) to prevent seepage of the urea solution. Rice straw was chopped with cutlass into lengths of 3-5 cm. Twenty five kilograms of chopped straw were treated with 1.65 kg of fertilizer grade urea dissolved in 22 litres of water (6.5% urea, 40% moisture). The chopped rice straw was spread on the polysack sheet in layers. Successive layers of chopped rice straw were sprayed with urea solution, using a watering can and thoroughly mixed. This process continued until all the straw and urea solution were used up. The ends of the sheet were then tied together, diagonally. During the tying process, pressure was applied to the mass of chopped rice straw with the feet to expel as much air as possible. After one week the polysack sheet was opened and the contents aired for a day after which it was ready for use.

**Diets and their feeding**

A total of 16 cow (274.2±6.49 kg) and calf (58.6±3.57 kg) pairs were randomly allocated to four treatments as follows:

1. Natural grazing only (control) (Diet 1).
2. Natural grazing plus urea-ammoniated rice straw ad libitum (Diet 2).
3. Natural grazing plus untreated rice straw and *Griffonia simplicifolia* (Diet 3).
4. Natural grazing plus untrated rice straw and wheat bran (Diet 4).

Cows chosen had calved three 3
months previously. There were 4 cow and calf pairs per treatment. Cows on supplementary feeding treatments (Diets 2, 3 and 4) were fed individually in pens constructed for that purpose. Water and mineral lick were provided to cows in all treatments. Wheat bran and *Griffonia simplicifolia* were first fed to the cows on diets 3 and 4 for 30 minutes, in the morning at about 7.00am, after which they were removed and replaced with chopped untreated rice straw. The quantity of bran and *Griffonia simplicifolia* consumed was noted. Untreated rice straw was available to the cows until grazing time and was also available on their return from grazing until feeding time the next morning. The amount of untreated rice straw that had been eaten was noted. Urea-ammoniated rice straw was fed at the same time as wheat bran and *Griffonia simplicifolia* and was also available to cows until grazing time, and then on their return from grazing until feeding time the next morning. The amount of urea-ammoniated rice straw that had been eaten was also noted. There was an adjustment period of two weeks before measurements started. During this period, the amounts of wheat bran and *Griffonia simplicifolia* eaten were respectively averaged and fed to the animals during the measurement phase. On their return from grazing all control animals were held in a pen to prevent them from gaining access to supplement of hay (*Bracharia spp*) which was fed to the rest of the herd as a dry season feed supplement. Animals on the feeding treatments were returned to their feeding pens.

**Parameters measured**

Measurements made were: initial weights of cow and calf, monthly weights of cow and calf, initial body condition score

---

**Table 3. Least square means of Daily Total dry matter intake (TDMI) (grams) of supplements as affected by treatment.**

<table>
<thead>
<tr>
<th></th>
<th>CTRL</th>
<th>UTS</th>
<th>GRISTR</th>
<th>WBRSTR</th>
<th>SED</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min.</td>
<td>-</td>
<td>61.1</td>
<td>161.2</td>
<td>408.3</td>
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<td></td>
</tr>
<tr>
<td>Max.</td>
<td>-</td>
<td>871.1</td>
<td>467.7</td>
<td>871.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>-</td>
<td>460.3</td>
<td>319.4</td>
<td>775.4</td>
<td>312.03</td>
<td>*</td>
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</table>

Daily total dry matter intake

<table>
<thead>
<tr>
<th></th>
<th>CTRL</th>
<th>UTS</th>
<th>GRISTR</th>
<th>WBRSTR</th>
<th>SED</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>-</td>
<td>405.4</td>
<td>247.1</td>
<td>646.2</td>
<td>314.59</td>
<td>*</td>
</tr>
<tr>
<td>February</td>
<td>-</td>
<td>474.1</td>
<td>326.3</td>
<td>857.8</td>
<td>284.97</td>
<td>***</td>
</tr>
<tr>
<td>March</td>
<td>-</td>
<td>542.3</td>
<td>450.1</td>
<td>869.2</td>
<td>290.30</td>
<td>*</td>
</tr>
</tbody>
</table>

CTRL - Control;
UTS - Urea ammoniated rice straw;
GRISTR - Griffonia plus untreated rice straw;
WBRSTR - Wheatbran plus untreated rice straw.

Means within a row postscripts are not significantly different (P>0.05).
Table 4. Least square means (± SE) of daily partial milk yield as affected by treatment.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Milk Yield (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.64±0.029</td>
</tr>
<tr>
<td>Urea-ammoniated rice straw</td>
<td>0.74±0.027</td>
</tr>
<tr>
<td>Griffonia + Untreated rice straw</td>
<td>0.70±0.027</td>
</tr>
<tr>
<td>Wheatbran + untreated rice straw</td>
<td>0.69±0.029</td>
</tr>
<tr>
<td>Parity</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>0.67±0.026</td>
</tr>
<tr>
<td>Medium</td>
<td>0.70±0.029</td>
</tr>
<tr>
<td>High</td>
<td>0.71±0.021</td>
</tr>
</tbody>
</table>

Table 5. Least square means (± SE) for effect of treatment on cow and calf growth rate.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Growth rate (Kg day⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cow</td>
</tr>
<tr>
<td>Control</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td>-0.31±0.056</td>
</tr>
<tr>
<td>Urea-ammoniated rice straw</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td>-0.30±0.052</td>
</tr>
<tr>
<td>Griffonia + Untreated rice straw</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td>-0.31±0.052</td>
</tr>
<tr>
<td>Wheatbran + untreated rice straw</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td>-0.19±0.058</td>
</tr>
<tr>
<td>Parity</td>
<td>(3)</td>
</tr>
<tr>
<td>Low</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.22±0.061</td>
</tr>
<tr>
<td>Medium</td>
<td>(8)</td>
</tr>
<tr>
<td></td>
<td>-0.29±0.038</td>
</tr>
<tr>
<td>High</td>
<td>(5)</td>
</tr>
<tr>
<td></td>
<td>-0.32±0.050</td>
</tr>
</tbody>
</table>

Number of animals in parentheses
Table 6. Least square means of Cow body condition score as affected by treatment.

<table>
<thead>
<tr>
<th></th>
<th>CTRL</th>
<th>UTS</th>
<th>GRISTR</th>
<th>WBRSTR</th>
<th>SED</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min.</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max.</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>4.3</td>
<td>4.7</td>
<td>4.6</td>
<td>4.5</td>
<td>0.46</td>
<td>NS</td>
</tr>
<tr>
<td>January</td>
<td>4.9</td>
<td>5.3</td>
<td>5.3</td>
<td>4.5</td>
<td>0.71</td>
<td>NS</td>
</tr>
<tr>
<td>February</td>
<td>4.3</td>
<td>4.6</td>
<td>4.1</td>
<td>4.0</td>
<td>0.51</td>
<td>NS</td>
</tr>
<tr>
<td>March</td>
<td>3.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.48</td>
<td></td>
</tr>
</tbody>
</table>

CTRL - Control;  
UTS - Urea ammoniated rice straw;  
GRISTR - Griffonia plus untreated rice straw;  
WBRSTR - Wheatbran plus untreated rice straw.

Means within a row postscripts are not significantly different (P>0.05).

of cow and monthly body condition score of cow, intake of supplements and milk yield. All weights were estimated using the Dalton weighband (Dalton Supplies Ltd, England). Body condition score of cows was estimated using the 9-point scale developed at the International Livestock Centre for Africa<sup>15</sup>. Partial milk yield was measured once a week and averaged for the whole period. Mean daily dry matter intake of all supplements was averaged for the month. Parity was classified as low (parity 1 and 2), medium (parity 3 and 4) or high (parity 5 and above).

Chemical analysis

Samples of untreated rice straw, urea-ammoniated rice straw, *Griffonia simplicifolia* and wheat bran were analysed for nitrogen<sup>13</sup> and detergent fibres (NDF, ADF, ADL<sup>14</sup>). Organic matter was determined as the weight loss after ignition in a furnace at 550 for 3 hours. Hemicellulose was calculated as the difference between NDF and ADF.

Statistical procedures

Data were analysed using the GLM procedure of the Statistical Analysis Systems Institute<sup>16</sup>. The regression of monthly cow and calf weights on time (month) was used to estimate growth rate of cow and calf respectively. The effects of treatment and parity of cow, on cow and calf growth rate, intake of supplements and milk yield were examined. Analysis of variance for repeated measures<sup>17</sup> was used to assess the change in body condition score and intake of supplements with time (month).

Results

Chemical composition of experimental feeds.

Proximate chemical composition of experimental feeds are shown in Table 1.
Dry matter values ranged from 891 g kg⁻¹ for untreated rice straw to 389 g kg⁻¹ for _Griffonia simplicifolia_. Crude protein values (N X 6.25) were highest in _Griffonia simplicifolia_ (178.2 g kg⁻¹) and lowest in the rice straw (44.9 g kg⁻¹).

**Dry matter intake and milk yield**

Mean intakes (as fed) of wheat bran and _Griffonia simplicifolia_, during the adjustment phase were 452.0±25.67 grams and 527.3±5.78 grams, respectively. Four hundred and fifty grams of wheat bran (450g) and 530g of _Griffonia simplicifolia_ were, therefore, fed to the cows on those treatments during the measurement phase.

Dry matter intakes of untreated rice straw as affected by diet are shown in Table 2. Dry matter intake of untreated rice straw was significantly (P<0.001) higher in the diet as compared to diet 3 in all the months. There was a general increase in dry matter intake of untreated rice straw from January to March irrespective of diet.

Table 3 shows the Least square means of daily total dry matter intake. Diet 4 had the highest daily dry matter intake and this was significantly different (P<0.05), from the other diets. There was significant effect of month of observation (P<0.01) and also a significant diet X month observation interaction (P<0.01). In January, diet 3 was not significantly different (P>0.05) from diet 2 but was significantly different (P<0.05) from diet 4. Diets 2 and 4 were not significantly different (P<0.05) from each other. In February, diet 4 was significantly (P<0.05) different from the other two diets. The situation in March was similar to that in January. There was a general increase in dry matter intake from January to March for all diets.

Partial milk yields from the various diets were not significantly (P>0.05) different (Table 4). Parity also had no effect on partial milk yield (P>0.05).

**Cow and calf growth rates**

Table 5 shows cow and calf growth rates (kg day⁻¹). There were no significant differences (P> 0.05) between treatments for either cow or calf growth rate. Generally, all cows lost weight during the period. Cows

---

**Table 7. Least square means of Cow body condition score as affected by parity.**

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>SED</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min.</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max.</td>
<td>6.0</td>
<td>6.0</td>
<td>5.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>4.3</td>
<td>4.6</td>
<td>4.4</td>
<td>0.51</td>
<td>NS</td>
</tr>
</tbody>
</table>

**Condition score**

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>SED</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>4.6</td>
<td>5.3</td>
<td>4.9</td>
<td>0.76</td>
<td>NS</td>
</tr>
<tr>
<td>February</td>
<td>4.2</td>
<td>4.3</td>
<td>4.0</td>
<td>0.56</td>
<td>NS</td>
</tr>
<tr>
<td>March</td>
<td>3.5</td>
<td>3.9</td>
<td>3.1</td>
<td>0.53</td>
<td>NS</td>
</tr>
</tbody>
</table>
on diet 4 showed the least weight loss (-0.19) compared to those on diets 3 (-0.31), 2 (-0.30), and 1 (-0.31). Growth rate of calves, followed a similar pattern with diet 4 having the highest growth rate (0.23), followed closely by diet 2 (0.20) with diet 1 (0.15) and diet 3 (0.14) following in that order. The effects of parity were also not significant (P>0.05). For both cow and calf growth rates, however, cows with high parity had the worst performance (-0.32 and 0.15) with cows of low parity having the best performance (-0.22 and 0.19).

Cow body condition score

Cow body condition scores as affected by treatment are shown in Table 6. There was significant effect of month of observation (P<0.05) but no significant month X diet interaction (P>0.05). By the end of the experiment, in March, diet 1 had significantly lower (P<0.05) body condition score as compared to diets 3 and 4 but was not significantly different (P>0.05) from diet 2. All the supplemented diets were also significantly different (P>0.05) from each other. Cow body condition score was not significantly affected (P>0.05) by parity (Table 7).

Discussion

Increase in crude protein content is one of the advantages of urea-ammoniation of straw. The values reported in this study are higher than the 84 g kg⁻¹ obtained in an earlier study but lower than the value of 104.5 g kg⁻¹ reported in another study. The rate of application was similar (6.5% urea and 40% moisture) and these differences may be accounted for by the different types of silos used and the length of the treatment period.

The loss of condition of cows as the dry season progressed has been reported by other authors. Cows often have to draw on their body reserves to be able to produce enough milk to feed the calf and as a result lose condition. The feeding of supplements appeared to help maintain the body condition of the cows.

The lack of significant difference in growth rates and milk yield between the various treatments may be explained by the results for total DM intake and DM intake of untreated rice straw. Animals were not used to the supplements and even though an adjustment period of two weeks was allowed before measurements were started intake of supplements were generally low in the first month. As the dry season progressed, however, and natural grazing became more limiting, cows ate more of the supplements. It has been reported that cattle did not readily accept supplemental feed in Ghana, and this was attributed to the fact that cattle were not used to supplementation and restricting them in pens to allow them to consume the supplement may also contribute to the low intake. In a dry season feeding trial carried out in Ghana it was also reported that calves that had previous exposure to supplementation consumed almost twice as much supplement as those that had no previous exposure.

Based on tropical livestock unit of 250 kg, it was estimated that a cow would eat at least 2.5% of its body weight which is equivalent to 6.25 kg of dry matter daily. The experiment aimed to provide about 25% of this (1.56 kg DM) in the form of supplements. In reality, daily total dry matter intake formed 5.1% for the Griffonia supplemented diet, 7.4% for the urea-ammoniated rice straw diet and 12.4% in
the wheat bran supplemented diet. Supplemented intakes were therefore not high enough to cause the expected increase in performance.

There is often a negative relationship between water content of roughage and voluntary intake of the roughage. The high moisture content of *Griffonia simplicifolia* may therefore have contributed to its low dry matter intake. It may be advisable to wilt leguminous forages for a day before feeding to increase dry matter intake. It has been stated, however, that chemical composition and degradation of foliages are normally altered due to drying. It has been observed for example, that fresh leucaena was highly degraded in the rumen and resulted in less substitution and less bypass protein when compared to the dry material. On the contrary other authors observed a high substitution rate for fresh leucaena, when fed as a supplement to teff straw, and suggested that bulkiness compared to degradability may be the first limiting factor in the control of intake of low quality roughages supplemented with tree leaves. There may therefore be need to study the wilting of foliages before feeding further. The less bulky wheat bran may have caused minimal substitution of untreated rice straw as compared to *Griffonia simplicifolia* and may explain the higher untreated rice straw intake in the wheat bran supplemented diet.

In conclusion, it appears that the feeding of untreated rice straw with either *Griffonia simplicifolia* or wheat bran is comparable to the feeding of urea-ammoniated rice straw as dry season feed supplement for cattle. Intake of supplements was generally low and may be the cause of less than expected improvement in performance. Cattle took a long time to adjust to the supplements and there is, therefore, the need to train cattle, probably after weaning, so that they are used to being fed a supplement. To ensure a dry matter intake, high enough to cause an appreciable change in production, the way forward may be the use of both leguminous browse and agro-industrial by-product as they would appear to complement each other.

**Acknowledgements**

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**References**

12. Quarshie, B.S. (1993). M.Phil. Thesis, Department of Animal Science, Faculty of
Agriculture, University of Ghana, Legon.


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THE EFFECTS OF REPLACING MAIZE WITH DRIED LEAVES OF DESMODIUM SPP ON THE GROWTH PERFORMANCE OF BROILER CHICKENS.

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LES EFFETS DE REMPLACER LE MAIS PAR DES FEUILLES SECHEES DE DESMODIUM SPP SUR LA PERFORMANCE DE CROISSANCE DES POULETS DE GRIL

Résumé

Au total, 200 poulets de gril asexués Arbor Acres âgés de 1 jour étaient utilisés pendant 7 semaines pour étudier les effets de remplacer le maïs dans la ration de démarrage (30 et 60 g/kg⁻¹) et l’aliment de finition (100 et 200 g/kg⁻¹) par Desmodium uncinatum ou D. intortum sur leur performance de croissance. Pendant la période de « la ration de démarrage », un gain pondéral beaucoup plus faible (P<0,05) comparé au régime-témoin a été noté en remplaçant 60 g de maïs par une ration de D. uncinatum kg⁻¹ ; par contre, aucune différence significative (P>0,05) n’a été observée chez les groupes sous traitement pour ce qui est de la consommation alimentaire et du taux de conversion. S’agissant de l’aliment de finition, le remplacement du maïs au-delà de 100 g/kg⁻¹ par Desmodium spp a considérablement diminué (P<0,05) le gain pondéral et beaucoup accru (P<0,05) le taux de conversion. Même si le rendement en carcase et la graisse de l’abdomen des poulets ont diminué avec l’augmentation de la quantité de feuilles de Desmodium spp dans l’aliment, la qualité de la carcase était comparable (P>0,05) entre le groupe-témoin et le groupe expérimental. Par conséquent, jusqu’à 60 g de maïs/kg⁻¹ dans la ration de démarrage peuvent être remplacés par des feuilles de Desmodium spp sans un effet négatif marquant sur la performance de croissance ; en revanche, le remplacement au-delà de 100 g/kg⁻¹ dans l’aliment de finition n’est pas techniquement justifié.

Summary

A total of 200 unsexed day-old Arbor acres broiler chicks were used for 7 weeks to study the effects of replacing maize in the starter (30 and 60 g kg⁻¹ diet) and finisher (100 and 200 g kg⁻¹ diet) diets with either Desmodium uncinatum or D. intortum on their growth performance. During the starter period, a significantly (P<0.05) lower weight gain as compared to the control diet, was only observed with the substitution of 60g maize with D. uncinatum kg⁻¹ diet but no significant difference (P>0.05) was recorded among treatment groups for feed consumption and feed conversion ratio. At finishing, however, the replacement of maize beyond 100 g kg⁻¹ with Desmodium spp significantly (P<0.05) decreased weight gain and significantly (P<0.05) increased feed conversion ratio. Although, the carcase yield and abdominal fat of birds decreased with increased level of Desmodium spp leaves in the diet, the carcase quality was comparable (P>0.05) between the control and test groups. Therefore, up to 60 g of maize kg⁻¹ starter diet can be substituted with Desmodium spp leaves without a significant negative effect on growth performance while substituting beyond 100g kg⁻¹ finisher diet is not technically justified.

* Corresponding Author.
Introduction

Cereals such as maize, wheat and sorghum are important foodstuffs in most developing countries of the world. Also, large amounts of these cereals are being included in animal feeds, particularly poultry feeds of which they form 40-70%. While the existence of surplus in cereal production is playing a major role in poultry production in the temperate countries, there is not enough production for both man and animals in tropical countries including Africa. This inadequate cereal production has justified an increasing interest for their substitution with non-conventional agricultural by-products in poultry diets. Sweet potato (Hypomoea batatas), ndole (Vernonia spp) and perennial peanuts (Arachis glabrata Benth) leaves widely available in most of the tropics including Cameroon, have been successfully used to replace maize in broiler finisher diets. Téguié reported that Leucaena leucocephala and Desmodium spp leaves significantly improved daily egg production and could be used to supply xanthophyll to commercial layers without any detrimental effect on egg quality. Desmodium uncinatum and D. intortum are widely spread natural legumes found in Cameroon, invading abundant and uncultivated areas. They are available throughout the year but their nutritive values in broiler feed is not known.

The objective of this study was, therefore, to investigate the effects of replacing graded levels of maize with Desmodium spp, during the starter and finisher periods, on the production performance of broiler chickens.

Materials and Methods

Animals and diets

A total of 200 day-old unsexed Arbor acres chicks were used. The birds were immunised against Newcastle, infectious bronchitis and Gumboro disease. Coccidiostatics were administered for 3 consecutive days from 15 days of age and every week thereafter. Antistress (Amintotal®; 1 g / 5l of water) was given before and after each vaccination and during transfer of birds from the brooding to the finishing housing.

The stems of Desmodium intortum (R) and Desmodium uncinatum (N) bearing leaves were collected without particular attention to the age and the quality of leaves from the University of Dschang Experimental Farm and its surroundings. The leaves of each species were sun-dried separately for 2-3 days and ground. Powders of Desmodium uncinatum (R) or D. intortum (N) leaves were used to replace 18 g (3%) or 36 g (6%) of maize in starter diet (R₃, R₅, N₃, N₅ respectively) and 56 g (10%) or 112 g (20%) of maize in finisher diet (R₁₀, R₂₀, N₁₀, N₂₀ respectively). The composition and determined analysis of experimental diets are given in Table 1 for the starter period and Table 2 for the finisher period.

The day-old chicks were randomly allocated to 5 treatment groups, each represented by 10 birds in 4 replicate bamboo cages and started according to usual brooding practices. Each treatment group was randomly fed ad libitum on one of the experimental starter diets. At the end of the starter period, all the birds of each treatment group were brought together and ran-
Table 1: Composition and chemical analysis of experimental broiler chickens starter diets (g kg⁻¹)

<table>
<thead>
<tr>
<th>DIET</th>
<th>Control</th>
<th>R₁</th>
<th>R₄</th>
<th>N₁</th>
<th>N₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>600.0</td>
<td>582.0</td>
<td>564.0</td>
<td>582.0</td>
<td>564.0</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>170.0</td>
<td>170.0</td>
<td>170.0</td>
<td>170.0</td>
<td>170.0</td>
</tr>
<tr>
<td>CMAV¹</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Fish meal</td>
<td>50.0</td>
<td>50.0</td>
<td>50.0</td>
<td>50.0</td>
<td>50.0</td>
</tr>
<tr>
<td>Wheat middlings</td>
<td>60.0</td>
<td>60.0</td>
<td>60.0</td>
<td>60.0</td>
<td>60.0</td>
</tr>
<tr>
<td>D. uncinatum</td>
<td>-</td>
<td>18.0</td>
<td>36.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>D. intortum</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>18.0</td>
<td>36.0</td>
</tr>
<tr>
<td>NaCl</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Bone meal</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
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</tr>
</tbody>
</table>

CHEMICAL ANALYSIS

<table>
<thead>
<tr>
<th></th>
<th>Dry matter</th>
<th>Crude protein</th>
<th>Crude fibre</th>
<th>Crude fat</th>
<th>M.E. (Kcal/Kg)²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>797.8</td>
<td>178.4</td>
<td>30.8</td>
<td>41.4</td>
<td>2999.1</td>
</tr>
<tr>
<td>R₁</td>
<td>797.3</td>
<td>181.0</td>
<td>32.7</td>
<td>41.4</td>
<td>2986.6</td>
</tr>
<tr>
<td>R₄</td>
<td>796.8</td>
<td>183.3</td>
<td>38.4</td>
<td>41.4</td>
<td>2974.1</td>
</tr>
<tr>
<td>N₁</td>
<td>797.4</td>
<td>181.4</td>
<td>33.3</td>
<td>41.6</td>
<td>2982.4</td>
</tr>
<tr>
<td>N₄</td>
<td>797.0</td>
<td>183.9</td>
<td>39.0</td>
<td>41.8</td>
<td>2965.7</td>
</tr>
</tbody>
</table>

¹ (CMAV10) composition (g kg⁻¹): protein (520), fat (40), fibre (20), Ca (90), P (37.5), Lysine (28), Methionine (23) Methionine + Cystine (28), M.E. (2300 kcal kg⁻¹), vitamin (100 kg): A (15x10⁶ IU), D3 (3x10⁴ IU), E (3x10⁴ mg), vitamin (mg kg⁻¹): K3 (26), B1 (25), B2 (60), B6 (25), B12 (0.3), folic acid (20), trace minerals (mg kg⁻¹): Fe (1650), Cu (200), Zn (1300), Mg (850), Se (3).

² Metabolizable energy was calculated according to Sibbald (1980) quoted by INRA¹³.
Table 2: Composition and chemical analysis of experimental broiler chickens finisher diets (g kg⁻¹)

<table>
<thead>
<tr>
<th>DIET</th>
<th>Control</th>
<th>R₁₀</th>
<th>R₂₀</th>
<th>N₁₀</th>
<th>N₂₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>560.0</td>
<td>504.0</td>
<td>448.0</td>
<td>504.0</td>
<td>448.0</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>65.0</td>
<td>65.0</td>
<td>65.0</td>
<td>65.0</td>
<td>65.0</td>
</tr>
<tr>
<td>CMAV¹</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Cotton seed cake</td>
<td>70.0</td>
<td>70.0</td>
<td>70.0</td>
<td>70.0</td>
<td>70.0</td>
</tr>
<tr>
<td>Wheat middlings</td>
<td>200.0</td>
<td>200.0</td>
<td>200.0</td>
<td>200.0</td>
<td>200.0</td>
</tr>
<tr>
<td>D. uncinatum</td>
<td>-</td>
<td>56.0</td>
<td>112.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>D. intortum</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>56.0</td>
<td>112.0</td>
</tr>
<tr>
<td>NaCl</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>

CHEMICAL ANALYSIS

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter</td>
<td>811.8</td>
<td>810.4</td>
<td>808.6</td>
<td>810.5</td>
<td>809.1</td>
</tr>
<tr>
<td>Crude protein</td>
<td>141.4</td>
<td>149.6</td>
<td>157.7</td>
<td>150.6</td>
<td>159.7</td>
</tr>
<tr>
<td>Crude fibre</td>
<td>41.2</td>
<td>41.3</td>
<td>41.4</td>
<td>41.9</td>
<td>42.5</td>
</tr>
<tr>
<td>Crude fat</td>
<td>47.9</td>
<td>53.6</td>
<td>69.1</td>
<td>55.4</td>
<td>72.7</td>
</tr>
<tr>
<td>M.E. (Kcal/Kg)²</td>
<td>2950.4</td>
<td>2911.5</td>
<td>2872.5</td>
<td>2898.5</td>
<td>2846.6</td>
</tr>
</tbody>
</table>

¹ (CMAV10) composition (g kg⁻¹): protein (520), fat (40), fibre (20), Ca (90), P (37.5), Lysine (28), Methionine (23) Methionine + Cystine (28), M.E. (2300 kcal kg⁻¹), vitamin (100 kg): A (15x10⁶ IU), D3 (3x10⁴ IU), E (3x10⁴ mg), vitamin (mg kg⁻¹): K3 (26), B1 (25), B2 (60), B6 (25), B12 (0.3), folic acid (20), trace minerals (mg kg⁻¹): Fe (1650), Cu (200), Zn (1300), Mg (850), Se (3).

² Metabolizable energy was calculated according to Sibbald (1980) quoted by INRA¹³.
Table 3: Weight gain, feed consumption and feed conversion ratio of Arbor acres broiler chicks fed on diets containing D. uncinatum (R) and D. intortum (N) leaves from day old to 4 weeks of age.

<table>
<thead>
<tr>
<th>Diet</th>
<th>Weight gain ± SEM (g)</th>
<th>Feed consumption ±SEM (g)</th>
<th>Feed conversion ratio (g feed g⁻¹ gain)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>620.61 ± 32.75ᵃ</td>
<td>1270.75 ± 43.66ᵃ</td>
<td>2.09 ± 0.51ᵃ</td>
</tr>
<tr>
<td>R3</td>
<td>591.50 ± 36.78ᵃᵇ</td>
<td>1290.12 ± 31.65ᵃ</td>
<td>2.28 ± 0.80ᵃ</td>
</tr>
<tr>
<td>R6</td>
<td>557.11 ± 25.26ᵇ</td>
<td>1263.86 ± 36.22ᵃ</td>
<td>2.18 ± 0.53ᵃ</td>
</tr>
<tr>
<td>N3</td>
<td>583.13 ± 50.14ᵃᵇ</td>
<td>1286.75 ± 63.66ᵃ</td>
<td>2.37 ± 0.84ᵃ</td>
</tr>
<tr>
<td>N6</td>
<td>597.67 ± 49.02ᵃᵇ</td>
<td>1335.87 ± 50.79ᵃ</td>
<td>2.54 ± 0.91ᵃ</td>
</tr>
</tbody>
</table>

Means in a column carrying the same letter are not significantly different (P>0.05)

**Results**

Analysis of the nutritive value (g kg⁻¹ DM) of the powders was done according to the AOAC⁵ for dry matter (R 880.5, N 884.5), crude protein (R 232.5, N 250.4), crude fibre (R 128.0, N 160.0), crude fat (R 45.4, N 55.5) and ash (R 66.3, N 66.8). Both Desmodium uncinatum and D. intortum had higher crude protein and total mineral content values than maize. However, their fibre content was four to six times higher, 128 g kg⁻¹ and 160 g kg⁻¹ respectively for D. uncinatum and D. intortum, as compared with 28 g kg⁻¹ for maize.

The data on weight gain, feed consumption and feed conversion ratio for Arbor acres broiler chickens during the starter period are presented in Table 3. No significant difference (P<0.05) was observed between treatment groups for feed consumption and feed conversion ratio. However, weight gain was significantly (P<0.05) lower for birds on R6 as compared to the control. For the finisher period, bird groups fed on R10, N10 and N20 consumed significantly (P<0.05) more feed than the control while the inclusion of Desmodium spp leaves significantly increased feed conversion ratio values as compared to the control group.
### Table 4: Weight gain, feed consumption and feed conversion ratio of *Arbor acres* broiler chicks fed on diets containing *D. uncinatum* (R) and *D. intortum* (N) leaves from 5 to 7 weeks of age

<table>
<thead>
<tr>
<th>Diet</th>
<th>Weight gain ± SEM (g)</th>
<th>Feed consumption ±SEM (g)</th>
<th>Feed conversion ratio (g feed g⁻¹ gain)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1248.32 ± 186.08ᵃ</td>
<td>2675.42 ± 194.87ᵃ</td>
<td>2.18 ± 0.29ᵃ</td>
</tr>
<tr>
<td>R10</td>
<td>1293.39 ± 174.20ᵃ</td>
<td>3283.88 ± 367.87ᶜ</td>
<td>2.57 ± 0.34ᵇ</td>
</tr>
<tr>
<td>R20</td>
<td>1004.70 ± 177.93ᵇ</td>
<td>2809.54 ± 383.38ᵃᵇ</td>
<td>2.86 ± 0.50ᵇᶜ</td>
</tr>
<tr>
<td>N10</td>
<td>1093.43 ± 208.58ᵇ</td>
<td>2990.01 ± 275.70ᵇ</td>
<td>2.83 ± 0.56ᵇᶜ</td>
</tr>
<tr>
<td>N20</td>
<td>1021.71 ± 158.32ᵇ</td>
<td>3130.44 ± 252.18ᶜ</td>
<td>3.13 ± 0.50ᶜ</td>
</tr>
</tbody>
</table>

Means in a column carrying the same letter are not significantly different (P>0.05).

### Table 5: Effects of replacing maize by *Desmodium spp* leaves in broiler chickens diets on carcass characteristics (% body weight)

<table>
<thead>
<tr>
<th>Characteristics (%) BW</th>
<th>Control</th>
<th>R10</th>
<th>R20</th>
<th>N10</th>
<th>N20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carcass yield</td>
<td>75.26±0.02</td>
<td>72.36±0.85</td>
<td>73.48±0.61</td>
<td>72.35±2.82</td>
<td>72.75±1.14</td>
</tr>
<tr>
<td>Abdominal fat</td>
<td>2.04±0.19</td>
<td>1.46±0.50</td>
<td>1.21±1.12</td>
<td>0.82±1.17</td>
<td>0.43±0.05</td>
</tr>
<tr>
<td>Gizzard</td>
<td>2.05±0.14</td>
<td>2.21±0.22</td>
<td>2.24±0.37</td>
<td>2.20±0.17</td>
<td>2.38±0.18</td>
</tr>
<tr>
<td>Liver</td>
<td>2.00</td>
<td>2.24±0.07</td>
<td>1.85±0.25</td>
<td>2.05±0.36</td>
<td>2.03±0.11</td>
</tr>
<tr>
<td>Heart</td>
<td>0.44±0.0</td>
<td>0.54±0.15</td>
<td>0.47±0.00</td>
<td>0.47±0.04</td>
<td>0.44±0.10</td>
</tr>
<tr>
<td>Feathers</td>
<td>7.24±0.02</td>
<td>7.09±2.45</td>
<td>7.95±0.09</td>
<td>8.80±0.29</td>
<td>8.25±0.26</td>
</tr>
<tr>
<td>Legs</td>
<td>3.87±0.02</td>
<td>4.94±1.06</td>
<td>4.81±0.50</td>
<td>4.47±0.94</td>
<td>4.94±1.03</td>
</tr>
</tbody>
</table>
(Table 4). Weight gain was significantly (P<0.05) higher for the control and R10 groups as compared to the other three groups of birds.

Data on carcass quality of broiler birds are summarised on Table 5. The carcass yields of birds on test diets were lower than those of birds on control diets and decreased with increased level of Desmodium spp leaves in the diets. The percentage of gizzard, legs and feathers also increased with increasing amount of leaves in the diets. On the contrary, there was a linear decrease in abdominal fat with the inclusion of increased amount of Desmodium spp leaves in the diets. However, there was no significant (P>0.05) difference between the control group and the groups of birds fed on diets containing Desmodium spp leaves for carcass quality.

**Discussion**

The crude protein values obtained in the present study disagreed with those of Plaisance who reported that, depending on age, the crude protein and crude fibre content of Desmodium spp leaves varied from 143 to 178 g kg⁻¹ and from 295 to 340 g kg⁻¹ respectively. In earlier works, Lawes (1957) cited by Skerman and Compère respectively reported 182 and 236.3 g crude protein kg⁻¹ and 245.2 and 325 g crude fibre kg⁻¹ for Desmodium intortum and D. uncinatum respectively. These differences are, probably, related to the state of development and the type of soil from where the samples were collected.

The replacement of maize with Desmodium spp leaves in the starter and finisher diets of broiler chickens resulted in an increase of the crude protein but a reduction of the energy value of tested diets. This was associated with a higher crude protein and a lower energy content of the leaves as compared with maize.

In general, weight gain was lower and feed efficiency was poorer in all groups of birds including the controls as compared to suggestions by the Société des Provenderies du Cameroun (SPC) hatchery. These poorer performances were related to the poor quality of the control and experimental diets as the determined crude protein levels in both the starter and finisher diets were lower than the 215 and 190 g kg⁻¹ suggested by the SPC hatchery respectively for the starter and finisher diets.

During the starter period, although a significantly (P<0.05) lower weight gain was only observed with the diet where 60 g kg⁻¹ maize was replaced with D. uncinatum leaves, the inclusion of Desmodium spp leaves in the starter diet, generally, resulted in a decreased weight gain as compared with the control. Although, at finishing there was no difference between the control and the R10 groups, total weight gain by birds fed on R20, N10 and N20 were significantly lower than that recorded for the birds on the control diet. This suggests that Desmodium spp leaves may be used to replace maize at levels up to 100 g kg⁻¹ in broiler chickens finisher diets. The results of this study are similar to those of Tégua et al. who reported a decrease in total weight gain when increasing levels of sweet potato or perennial peanuts leaves were used to replace maize in broiler finisher diets. However, they are contrary to those of Tégua et al. who found that up to 300 g maize kg⁻¹ finisher diet could be replaced with sweet potato leaves without a significant negative effect on weight gain. The ap-
parent difference between the birds fed on diets where 100 g maize kg\(^{-1}\) feed was replaced with \textit{D. uncinatum} or \textit{D. intortum}, could be attributed to a higher crude fibre content of \textit{D. intortum} and a relatively lower energy content of diets containing these leaves.

Although the difference was not significant at the finisher period between the treatment groups for feed consumption and the efficiency of feed utilisation, the feed consumed by broiler birds on test diets and the feed conversion ratio values throughout the production period were generally higher than those of the birds in control groups. The higher feed intake of test feeds was to compensate for their lower energy value. Téguida \textit{et al.} \(^2,3\) however, reported no significant difference for feed consumption when maize was replaced with sweet potato, ndole or perennial leaf meals though with higher crude fibre content of diets.

Although the carcass yield of birds under the control diets was higher than that of birds under test groups, the yield recorded for all the groups of birds were in the range suggested by Mountney \(^11\). The high crude fibre and reduced energy levels in the test diets led to increased feed utilisation which relate to reduced fat anabolism. The observed increase in the feather mass with increasing amount of tested leaves in the diets suggests a compensatory process related to the drop in energy level of diets and associated reduction in fat reserves, and insulation of the body. No significant differences were detected among treatment groups for the proportion of gizzard and liver. However, there was a linear increase in the percentage of gizzard as the amount of \textit{Desmodium spp} in the diets increased. This indicated a more intense activity of the organ in the presence of a higher crude fibre content of diets containing the tested leaves. The reasons for the increase in the weight of the legs with increased levels of \textit{Desmodium spp} are not known.

References


Received for publication on 01 August, 2001.
Eighty percent of Kenya's land area, referred to as Arid Semi-arid Lands (ASAL) is unsuitable for arable farming, but suitable for livestock keeping\(^1\)\(^2\). Climatic changes in the ASAL are adverse alternating between droughts and floods, and are known to severely affect production by predisposing to disease, water and feeds availability.

Baringo district in the rift Valley of Kenya is about 90% ASAL, receiving an average annual rainfall of 600mm. The communities living in this district are mainly pastoralists keeping cattle, camels, sheep, goats and donkeys\(^3\)\(^4\).

The objective of this study was to document some of the major livestock production constraints amongst small holder pastoralists due to water, feeds, disease and socioeconomic problems, especially these associated with climatic changes.

A cross-sectional survey was carried out involving administration of a questionnaire to sixty (60) randomly selected small holder households in two divisions of Marigat and Nginyang representing typical ASAL conditions. The key questions sought information on livestock herd structure, sources of water for livestock and human consumption, feeding and feed resources and livestock losses from causes other than disease.

Fifty-nine of the respondents interviewed owned goats, making it the most popular animal species in the district. Sheep on the other hand was popular only in parts of Marigat division, while 53 households owned cattle which were usually grazed in safer hilly areas due to fear of cattle rustling, especially in the Nginyang division.

From all the 60 respondents it emerged that there were five water sources. Table 1. indicates frequency of use and average distances from homesteads. The river was the most popular water source for 96.7\% of the households but most rivers are seasonal. In the dry periods, distances of up to 50 kilometers were covered in search of water. Dams were used by 30\%, while 10\% used boreholes. Piped water and lake water were each available only to 8.3% of the respondents.

Table 1 also shows the feeding and feed resources. All households (100\%) depended on communal grazing land, migrations to greener pastures was used by 60\% of the households, while loaning animals to distant relatives in adverse
weather was practised by 33.3%. It is clear that very few households (8.3%) interviewed have their own pastures. Supplementation was practised by 10%, especially fig tree leaves, pods, and maize stovers which were collected to feed kids and lambs which often were restricted around homesteads.

Table 2 tabulates various causes of mortality other than disease. Starvation during droughts, predation of small ruminants by wild animals, lack of water, cattle rustling and flooding were the common causes of mortality.

Table 1: Sources of water, feeding and feeds

<table>
<thead>
<tr>
<th>Water</th>
<th>River</th>
<th>Dam</th>
<th>Piped water</th>
<th>Borehole</th>
<th>Lake</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>58(60), 96.7%</td>
<td>18(60),3.0%</td>
<td>5(60),8.3%</td>
<td>5(60),10%</td>
<td>5(60),8.3%</td>
</tr>
<tr>
<td></td>
<td>0.5-50</td>
<td>0.5-10</td>
<td>0-0.5</td>
<td>0.5-10</td>
<td>3-10</td>
</tr>
<tr>
<td>Feeding and feeds</td>
<td>Communal grazing land</td>
<td>Animal loaned to relatives</td>
<td>Own Pasture</td>
<td>Supplementation</td>
<td>Migration</td>
</tr>
<tr>
<td></td>
<td>60(60),100%</td>
<td>20(60),33.3%</td>
<td>5(60),8.3%</td>
<td>18(60),0%</td>
<td>36(60),60%</td>
</tr>
<tr>
<td></td>
<td>0.5-20</td>
<td>20-100</td>
<td>0-1</td>
<td>-</td>
<td>5-80</td>
</tr>
</tbody>
</table>

Table 2: Losses from causes other than diseases

<table>
<thead>
<tr>
<th>Lack of water</th>
<th>Starvation</th>
<th>Predation</th>
<th>Floods</th>
<th>Rusting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported</td>
<td>24(60)</td>
<td>47(60)</td>
<td>44(60)</td>
<td>11(60)</td>
</tr>
<tr>
<td>Frequency</td>
<td>40%</td>
<td>78.3%</td>
<td>73.3%</td>
<td>18.3%</td>
</tr>
<tr>
<td>Remarks</td>
<td>mostly kids</td>
<td>mostly cattle</td>
<td>and lambs</td>
<td></td>
</tr>
</tbody>
</table>
The high dependence on communal grazing lands and rivers as sources of water for human and livestock use, resulted in crowding and pressure on these resources creating the risks of:

i) disease transmission, especially the epidemics like Foot and mouth disease, and contagious Caprine Pleuropneumonia (CCPP), and endoparasites

ii) depletion of feed resources and

iii) damage to environment.

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References


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SHORT COMMUNICATION

A SURVEY OF ANTHELMINTIC RESISTANCE IN EQUINE ESTABLISHMENTS AROUND HARARE, ZIMBABWE

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Anthelmintic resistance has been recorded in many parts of the world\(^{1}\). The phenomenon occurs when a parasite has the heritable ability to withstand the effects of an anthelmintic administered at the recommended therapeutic dose\(^{1}\). Anthelmintic resistance is believed to be an irreversible, selective process which has a genetic basis, and is inherited as a polygenic trait\(^{1}\). Another theory is that the resistance is pre-adaptive, meaning that the genes conferring resistance are already present in the population at a low frequency\(^{1}\). The phenomenon is well documented in ruminant helminths, particularly *Haemonchus contortus*, and studies have been carried out in Zimbabwe in this regard\(^{2,3}\).

In most countries other than Zimbabwe, anthelmintic resistance in equines has been recorded in numerous studies\(^{4,5}\). To date, no investigation has been undertaken in Zimbabwe and hence the objective of this study was to investigate anthelmintic resistance in horse establishments around Harare.

A field investigation to detect anthelmintic resistance was conducted on four randomly selected equine establishments around Harare from September 2000 to March 2001. Four establishments were selected randomly out of ten with the number of horses in each establishment ranging from 32 to 120. All horses were thoroughbreds or thoroughbred crosses and were used for various purposes ranging from stud purposes, patrols and parading.

A questionnaire designed to collect information about each establishment was administered through personal interviews with the owner or manager. These included census of horses, anthelmintics used in the past 5 years, frequency of dosing and whether anthelmintic resistance was suspected.

Horses were randomly selected from each establishment by a lottery method and their faecal samples were examined for eggs per gram of faeces (epg) using the modified McMaster technique\(^{6}\). Based on the results of faecal examination, horses with a faecal worm egg count of 250 or more were selected and identified. Control groups were included in the study. The following anthelmintics were used: Fenbendazole (Zerofen\(^{\mathrm{R}}\) 10%, CAPS, Zimbabwe), 10 mg kg\(^{-1}\) orally; Oxifendazole (Systemax\(^{\mathrm{R}}\), Coopers, Zimbabwe), 4.5 mg kg\(^{-1}\) orally and Levamisole (Chanaverm\(^{\mathrm{R}}\), Agricura, Zimbabwe), 5 mg kg\(^{-1}\) orally.

Equal number of horses were used for the treatment group and for the control group, with the total of all groups being a minimum of 10% of the total number of horses in the establishment. Allocation of animals within the groups was random. The choice of

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* Corresponding Author.
anthelmintic(s) used was based on the questionnaire survey (see Table 1). The anthelmintics were administered as oral drenches at the dosage recommended by the manufacturers. The weight of each animal was estimated using a girth tape. Faecal samples were collected from the experimental and control group, followed by anthelmintic treatment of the experimental group at day 0. Ten days post-treatment, faecal samples from animals in the experimental and control groups were examined for worm eggs. Data on epg was transformed to logarithm (count + 1) to calculate the geometric mean (GM). The GM of pre- and post-treatment faecal egg counts for experimental and control groups were compared on each establishment and the faecal egg count reduction percentage (FECR %) was calculated for each group. The formula used to calculate FECR % was \((1 - T_i/T_j, C_j/C_i)\) * 100 where T and C are the geometric means of treated and control groups respectively. The subscripts 1 and 2 designate counts before and after treatment, respectively.

To determine the genera or species of nematodes that were resistant to the anthelmintics administered, pre-treatment and post-treatment faecal samples were pooled in each experimental and control group for culture. Standard procedures for preparation and identification of \(L_3\) were followed as described by Thienpont(7).

Information about the use of anthelmintics in the last five years for the four establishments surveyed is shown in Table 1. Anthelmintics used were fenbendazole (FBZ), oxendazole (OXF), levamisole (LEV), piperazine (PIP), pyrantel (PYR), ivermectin (IVM) and doramectin (DOR). The benzimidazole compounds were the most frequently used anthelmintics. Ivermectin was used on three of the farms and was not tested on the farms as the formulation recommended for horses was unavailable at the time the study was carried out.

FECR % less than 95 % has been documented as an indication of the presence of anthelmintic resistance(1). The calculated faecal egg count reduction percentages were very low, ranging from 0 % for levamisole and fenbendazole to 88.3%

| Table 1: Summary of anthelmintics used on the four establishments from 1995 - 2000 |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Stud/Farm Name                | Last used Anthelmintics | Anthelmintics used in the last 5 Years | No. of treatments/year |
| Lone Oak Stud                 | PIP + FBZ        | + + + + + - + - | 12               |
| Morris Depot                  | IVM             | - + - - - + - | 2                |
| Chikurubi Prison              | PIP             | + - - + - - | 6                |
| Mary Down Stud                | PIP + LEV       | + - + + + + | 12               |

+ denotes anthelmintic used
- denotes anthelmintic not used

FBZ = fenbendazole; OXF = oxendazole; LEV = levamisole; PIP = piperazine;
PYR = pyrantel; IVM = ivermectin; DOR = doramectin
Table 2: Geometric means of pre- and post-treatment faecal egg counts reduction percentages (FECR %) following treatment with different anthelmintics

<table>
<thead>
<tr>
<th>Farm/Stud name</th>
<th>Drug Tested</th>
<th>N</th>
<th>Pre-Rx (Range)</th>
<th>Post-Rx (Range)</th>
<th>FECR%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lone Oak Stud</td>
<td>Fenbendazole 9</td>
<td>842,5 (300-3350)</td>
<td>1642,7 (400-4850)</td>
<td>2,5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Levamisole 9</td>
<td>838,2 (300-2500)</td>
<td>1746,7 (450-4100)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control 6</td>
<td>1704,8 (400-2600)</td>
<td>3427,7 (1300-6300)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Morris Depot</td>
<td>Oxfendazole 5</td>
<td>409,3 (300-600)</td>
<td>21,4 (0-450)</td>
<td>88,3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control 4</td>
<td>527,8 (200-850)</td>
<td>234,4 (100-500)</td>
<td>50,1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1193,1 (300-5750)</td>
<td>731,9 (50-1650)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Chikurubi Prison</td>
<td>Fenbendazole 9</td>
<td>1881,2 (300-5750)</td>
<td>575,4 (50-1650)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Mary Down Stud</td>
<td>Fenbendazole 6</td>
<td>984,8 (350-1450)</td>
<td>857,7 (450-1200)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control 6</td>
<td>940,4 (400-4300)</td>
<td>673,5 (100-10100)</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

N = number of horses
Pre-Rx = geometric mean of the FEC before treatment
Post-Rx = geometric mean of the FEC after treatment
Range = minimum and maximum faecal egg counts
FECR % = Faecal egg count reduction percentage

% for oxfendazole (see Table 2).
Both the pre-treatment and post-treatment larval cultures showed that small strongyles were the predominant group of nematodes on all establishments.
With regard to the existing worm burdens on each establishment, high individual pre-treatment egg counts were recorded on Lone Oak Stud and Chikurubi Prison Farm. The treatment interval among the establishments varied depending on the anthelmintic used and user-preference. All owners were aware of anthelmintic resistance, but did not routinely perform post-treatment faecal egg counts. Anthelmintics in Zimbabwe are not prescribed drugs – they can be obtained over-the-counter and there is a likely chance of abuse of the anthelmintics by horse-owners.

All four establishments dewormed their horses indiscriminately. The weight of the animal was estimated by observation alone, and is often inaccurate. A regular method of
estimation such as use of a girth tape would be preferable. Morris Depot and Chikurubi Prison Farm do not always have anthelmintics for use due to economic constraints. It is recommended to deworm horses with counts greater than 300 eggs per gram\(^6\). This will reduce costs and minimize development of anthelmintic resistance. Dose-and-move strategies may well select heavily for resistance because all subsequent worms in the system are the progeny of survivors of the anthelmintic treatment\(^1\). Chikurubi Prison farm pastures cattle and horses together and this might be an effective means of reducing the total larval burden on the pasture, as there is no cross-infection of gastrointestinal nematodes of cattle and horses with the exception of *Trichostrongylus axei*\(^6\).

At Chikurubi Prison Farm, horses stayed permanently on the pastures, from which faeces were not collected, hence there was more chance of them ingesting the infective L\(_3\). At Morris Depot horses are stabled throughout the year, and faeces collected daily and this could explain the moderate level of egg counts before anthelmintic treatment.

This investigation revealed cyathostome resistance to levamisole and the benzimidazoles (oxfendazole and fenbendazole). The results agree with other reports of resistance elsewhere\(^{10-15}\). Cyathostomes do not readily develop resistance to oxfendazole\(^{11, 12, 13, 14, 16, 17}\) although there have been infrequent reports of resistance to oxfendazole where it has been used for several years\(^{13, 14, 17, 18}\). In this survey, resistance to oxfendazole was recorded at Morris Depot with a FECR % of 88.3 %.

Levamisole recorded the lowest FECR % and it cannot be said whether this was due to anthelmintic resistance alone, or natural inefficacy of the drug against cyathostomes. A levamisole-piperazine mixture has been found to be effective against benzimidazole-resistant strongyles\(^{19}\).

Pre-treatment and post-treatment cultures indicated that 100 % of larvae cultured were those of cyathostomes. Identification of cyathostomes to species level can indicate the species which the anthelmintic is effective against. For example, oxfendazole is less effective against *Cyathostomum coronatum*\(^{12}\).

The importance of environmental control and client education as suggested by Kline\(^9\) cannot be over-emphasized to horse-owners rather than relying on the use of anthelmintics alone. Any deworming program should be specific for a stud/farm depending on individual management and the anthelmintics found to be effective after post-treatment faecal egg counts.

The Medicine Control Authority of Zimbabwe should be encouraged to regulate the purchase of anthelmintics by horse owners so that only those proven to be experimentally effective are available on the market.

Further areas to be investigated are age differences when considering anthelmintic efficacy and identification of the cyathostomes to species level. Ivermectin is relied upon as an endectocide by many horse-owners, and its efficacy against benzimidazole-resistant strongyles should be investigated.

**Acknowledgements**

We would like to thank owners of the horse studs/farms, Dr. J. Barnwell for providing a list of unsuspecting horse-owners, and for practical information, and Dr. P. Woods for additional references. Kim Michael of Lone Oak Stud; Inspector
Matumbe of Morris Depot; Superintendent Matongo of Chikurubi Prison; Assistant Commissioner of Prisons Mazani the grooms of all establishments and Liz O'Toole of Mary Down Stud for their willingness to participate and their help.

References


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SHORT COMMUNICATION

THE SIGNIFICANCE OF STRONGYLOSIOSIS IN SMALL RUMINANTS IN PASTORAL SYSTEMS: THE CASE OF BARINGO DISTRICT

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'Department of Animal Health, Egerton University
P.O. Box 536, Njoro Kenya

'2Department of Animal Science, Egerton University
P.O. Box 536, Njoro Kenya

Small ruminants form a very significant proportion of the total number of livestock in the Baringo district of Kenya, whose land mass is 90% arid and semi-arid land (ASAL), therefore making a tremendous contribution to the economy of the mostly pastoralist households in this district. Health and disease however, constitute one of the important production constraints. Helminths are documented to cause significant economic losses in the small ruminants in the ASAL. The Veterinary department in Baringo District in their several annual reports point out Haemonchus contortus as the most predominantly encountered of the strongyle worms in the small ruminants. There has, however, been no systematic study to document the infection rates and the extent of the clinical strongylosis in the district, especially in the face of emerging drastic climatic changes of alternating severe droughts and floods, coupled with grazing pressure in the diminishing communal grazing lands and watering points.

The objective of this study was to document the infection rates of strongylosis, the levels of anaemia and the degree of awareness of the existence of the problem in sheep and goats amongst the pastoral households in the two ASAL divisions of Marigat and Nginyang. The study was conducted in two phases. In the first phase a cross-sectional survey involving the administration of a questionnaire to sixty smallholder pastoral households, randomly selected, sought to establish the level of usage, the types and frequency of usage of anthelmintics. In the second phase five grams of faecal samples were collected from sheep and goats from the herds in the same households visited in the first phase in both Marigat and Nginyang, once in the wet season following the October short rains of 1999, and once in the dry season in March 2000, on the basis of the bimodal rainfall distribution patterns. Strongyle egg counts were done using the modified McMaster technique. Whole blood with (EDTA) was also collected from the same...
Table 1: Anthelmintics and reported frequency of use

<table>
<thead>
<tr>
<th>Type of anthelmintic</th>
<th>Reported frequency</th>
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<tbody>
<tr>
<td>1. Nilzan (Levamisole +Oxyzanamide)</td>
<td>50(60) 83.3%</td>
</tr>
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<td>2. Wormicide (Levamisole)</td>
<td>25(60) 42.7%</td>
</tr>
<tr>
<td>3. Valbazen (Albendazole)</td>
<td>17(60) 28.3%</td>
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Table 2: Egg counts for strongyles

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<td>Sheep:</td>
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<td></td>
<td></td>
</tr>
<tr>
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Table 3: The PVC mean and range values

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( ) = No of total animals sampled.
animals for packed cell volume (PCV) using the microhaematocrit centrifuge method.

Table 1 is a summary of the results of the questionnaire on the usage and the types of anthelmintics used. Of the households interviewed 83.3% indicated that they had dewormed their animals at least once in the past six months. Levamisole emerged as the most frequently used type of anthelmintic under four different brand names, followed by albendazole. The most common source of anthelmintics was the local agro-vet shop in Marigat township, while the field veterinary staff also sold some anthelmintics to the stock owners.

In table 2 the strongyle egg counts are summarized. The mean values for sheep were 463 eggs per gram while for goats the mean value was 699, with an overall infection rate of 63.5% for sheep and 64.3% for goats. There was no significant difference between the sheep and goats in the two values. It was however noteworthy that 26.8% of the sheep sampled had a mean count of more than 500 epg, while 48.4% of the goats had a similar value, indicating more goats were in the moderate to heavy infection category compared to sheep.

Table 3 is a summary of the PCV results. It is noteworthy that the mean values for sheep, 24.4% and for goats, 24.0% are similar. Further analysis showed that 42.5% of the sheep sampled had a PCV below 20%, indicating a high level of anaemia while amongst the goats sampled only 19.3% had a PCV of less than 20%.

The frequency of anthelmintic usage of over 83% is an indication of the awareness of the significance of helminthosis as a production constraint. There, however, arose in the study important questions concerning
(i) the determination of dosage rates,
(ii) the frequency of deworming,
(iii) the widespread prolonged usage of levamizole derivatives with the risk of development of resistance and
(iv) the selective deworming of special animals in the herd, especially the breeders.

The high level of anaemia, especially among the sheep was a significant symptom of underlying poor health. Helminthosis definitely contributes to this situation.

The increasing pressure on communal grazing land and watering points calls for epidemiological studies to establish their impact on helminthosis in the small ruminants.

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References


Received for publication on 30th May, 2002.
SHORT COMMUNICATION

NUTRIENT COMPOSITION OF WHITE THORN (ACACIA SEYAL) AND DESERT DATE (BALANITES AEGYPTIACA).

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²Department of Animal Science, Egerton University
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Legume tree browses have been reported to be richer in protein and some minerals during dry seasons when grass is high in cellulose, lignin and gross energy¹. The objective of the current study was to determine the nutrient and mineral contents of Acacia seyal and Balanites aegyptiaca at Mogotio and Eming divisions of Koibatek districts in Kenya. Samples of Acacia seyal and Balanites aegyptiaca were taken from barks of tree branches and leaves, soft branch tips and fruits accordingly. Sampling was based on administrative locations and a systematic sampling procedure was used. The samples were prepared and analysed for dry matter (DM), crude proteins (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL) hemicellulose and cellulose²³. Analysis for mineral contents were carried out using atomic absorption spectrophotometer² for calcium (Ca), phosphorus (P), sulphur (S), magnesium (Mg), sodium (Na) and cobalt (Co) levels. The results of this analyses are provided in Table1.

Table 1. The nutrient and mineral composition of edible parts of Acacia seyal, Balanites aegyptiaca compared to Chloris gayana hay in g per Kg DM forage.

<table>
<thead>
<tr>
<th>Forage/Nutr</th>
<th>DM</th>
<th>CP</th>
<th>NDF</th>
<th>ADF</th>
<th>ADL</th>
<th>Ca</th>
<th>P</th>
<th>S</th>
<th>Na</th>
<th>Mg</th>
<th>Co</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. seyal</td>
<td>651</td>
<td>112</td>
<td>370</td>
<td>339</td>
<td>59</td>
<td>28.2</td>
<td>0.06</td>
<td>0.8</td>
<td>1.1</td>
<td>7.0</td>
<td>0.06</td>
</tr>
<tr>
<td>B. aegyptia</td>
<td>665</td>
<td>152</td>
<td>443</td>
<td>341</td>
<td>89</td>
<td>16.9</td>
<td>0.13</td>
<td>2.9</td>
<td>1.0</td>
<td>7.5</td>
<td>0.04</td>
</tr>
<tr>
<td>B. a. Fruits</td>
<td>653</td>
<td>97</td>
<td>628</td>
<td>417</td>
<td>49</td>
<td>6.0</td>
<td>0.13</td>
<td>3.0</td>
<td>0.9</td>
<td>11.0</td>
<td>0.05</td>
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<tr>
<td>C. gayana h</td>
<td>845</td>
<td>68</td>
<td>730</td>
<td>463</td>
<td>57</td>
<td>-</td>
<td>-</td>
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</table>

* Corresponding Author.
The amount of hemicellulose was 31 and 102 while the cellulose was 196 and 172 per Kg DM for *Acacia seyal* and *Balanites aegyptiaca* respectively. The edible forage improved in quality from less dry areas to drier parts where much of the material available for harvest could have been on use more frequently. The crude protein was particularly higher in dry regions for *Balanites aegyptiaca*.

Mineral contents did no show much variation between divisions which represented lower and upper ecological zone IV. Calcium content in *Acacia seyal* was high compared to other forages. The amount of CP in both *Acacia seyal* and *Balanites aegyptiaca* (Table 1) was relatively lower than the contents in other indigenous tree legumes but were within the ranges reported for legume trees in West Africa. *Balanites aegyptiaca* leaves have been reported to to contain 12-28% CP and to be highly palatable to cattle, sheep and goats. The differences in CP levels may be associated with differences in leaf to stem ratio of samples taken and the frequency of harvesting, which reflect the differences in maturity. The mean CP content in both tree legumes was above the 8% level considered to be critical for animal performance on the tropical forages. The high level of CP implies supplemental nitrogen when fed with low quality fibrous materials like straws, stover or hay, although this again will depend upon the amount of polyphenolic compound which have antagonistic effects on the digestibility of nitrogen.

Acid detergent fibre levels of *Acacia seyal* and *Balanites aegyptiaca* were higher than those of *Milletia thionningii* and *Albezia lebbeck* in West, while the cellulose was much lower for the former. The current finding agree with others which ranged between 13-29, 29-49 and 4-7% for hemicellulose, cellulose, cellulose and lignin respectively.

Calcium contents in *Acacia seyal* and *Balanites aegyptiaca* were double the amount for animal requirements. It has been reported that Ca in most forages is in satisfactory amounts to support production and supplementation will only be necessary for high yielding dairy cows. Phosphorus content in *Acacia seyal* was less than half the amount in *Balanites aegyptiaca*, although the amount in both trees were less than the requirements for both sheep and cattle. This was in agreement with the finding that there is low P in forages in high potential areas. The amount of Na, Mg and Co among the two tree legumes were higher than the amount recommended to meet ruminants requirements.

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SHORT COMMUNICATION

FRONTAL ABSCESS IN A FRIESIAN BULL IN KAMPALA UGANDA: A CASE REPORT

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Even in human medicine, there is paucity of published information on various aspects of bacterial infection of the head¹ but the situation is worse in veterinary medicine. Brain abscess is the diagnosis that must be ruled out in the patients suffering from Hereditary Haemorrhagic Telangiectasis or Oster-Weber-Rendu disease³. Neoplasm of the nasopharynx may predispose to otitis and suppurative infection of the brain⁴. A foreign body passing through the orbit in man may enter the cavernous sinus² causing abscess there without involvement of the brain. A case of infected hematoma in a man, with extensive necrosis of the galea and head with periostitis without brain involvement has been reported⁴. The casual organism of brain abscess in man appears to be mainly streptococci²,⁶. An epidemic of encephalitis in canaries initiated by ocular toxoplasmosis has been reported⁷.

Frontal abscess of sinus origin occasionally occurs in cattle as a complication of dehorning⁸. However, it is more common in sheep in the ethmoid cells due to Oestrus ovis infestation and Actinomyces (Corynebacterium) pyogenes is the common pathogen. In that case, the olfactory bulb is destroyed, giving access to the lateral ventricles and spread to the cerebral hemispheres. There is little tendency for infection to spread to the meninges from the point of entry or to invade the cortical gray matter, except when the formed abscess expands. Pharyngitis, especially in pigs, leads to otitis media and interna, ending with abscess of the cerebellopontine angle. Generally, epidural abscesses do not breach the tough dura to cause meningoencephalitis⁸. In this paper, we report a case of frontal sinus abscess that caused severe pressure on the brain without infection of the latter.

The case reported here was a prized Friesian bull on a progressive farm on the outskirts of Kampala City, Uganda. Soon after arrival on the farm, it began losing condition. A clinician treated him with broad-spectrum antibiotic combination of penicillin and streptomycin (Norbrook) at the rate of 1 ml/25 kg for two months and it gradually gained weight. On 25/11/2001 the bull was observed mounting a cow on heat at about 11.00a.m. By 12 noon, he was found dead with blood oozing from body orifices. Anthrax and East Coast fever were suspected and blood smear were made of blood taken from an ear vein. Lymph node smears were also made from the prescapular lymph node using a 17 gauge needle. The smears from blood and lymph node were stained with Giemsa’s stain and examined by the light microscope. Neither anthrax bacillus nor blood parasites were found and necropsy of the carcass was therefore perormed.

On gross examination, the carcass
was in good body condition. Froth mixed with blood oozed from the mouth and nose. Dark-coloured blood which did not clot oozed from the anus, and the cornea were covered in blood. The whole carcass was septicaemic with petechial and ecchymotic haemorrhages in most organs. The lymph nodes were enlarged, oedematous, and congested or haemorrhagic. The liver had multiple abscesses, the largest of which contained about 2 litres of thick creamy pus. While removing the skin of the head which looked grossly normal, a bean-shaped hole approximately 5 X 3 cm (Figure 1 & 2) appeared in the frontal bone from which thick creamy pus flowed. The total volume of pus was about 1½ litres. The pus was of the same colour and consistency with that in the liver. The hole was plugged by a piece of frontal bone which was adherent to and came off with the skin as it was flayed. The piece of bone as well as bone surrounding the hole was soft and cartilaginous, easily cut with a knife without any gritting sound.

The ventral segment of the frontal bone was also softened so that the frontal sinus was converted in to a spherical receptacle about 8 cm diameter filled with pus. Pressure of the abscess pushed the bone so that it became concave from the sinus (top) side and convex on the brain/dura side (Figure 3a). The bone in turn compressed the posterior portion of both cerebral hemispheres and the cerebellum, leaving a dent (Figure 3b). The lateral ventricles of the brain were tightly compressed from the posterior end but the anterior became enlarged with fluid (hydrocephalus).

On microscopic examination, the cerebral cortex showed little change in the form of mild focal degeneration of the grey matter in the outer cortex despite the pressure on it. The severest reaction was in the cerebellum where most neurones of granular layer had been destroyed, along with many Purkinje neurons (Fig 4). The molecular layer showed focal degeneration while both the brain and spinal cord were remarkably free of inflammatory cells or exudate, indicating that the dura mater was not affected. The portion of the outer segment of the frontal bone in contact with the abscess had granulation tissue infiltrated by lymphocytes and macrophages. There was osteomalacia and fibrosis with intense infiltration by lymphocytes and macrophages. There was loss of some neurons in the gasserian ganglion with eosinophilia and mild fibrosis of supporting the tissue. The lung showed haemorrhage of lobar distribution with blood in the alveoli, bronchioles and interlobular septae. The prescapular lymph node was oedematous with atrophy of mature lymphocytes. The kidneys showed focal deposition of calcium salts in the corticomedullary junction. The pituitary gland was hyperaemiac. Both skeletal and cardiac muscles contained numerous sarcocysts. The liver had mild hepatocellular degeneration in the portal triad and wide foci of blood that mimicked telangiectasis or haemangioma. In the testes there was severe tubular degeneration with complete loss of sertoli cells and partial loss of the basement membrane leaving degenerating spermatids isolated, with rare sighted of spermatozoa. The interstitium had also degenerated leaving very few Leydig cells.

It was noted that soon after arrival on the farm, the bull suffered malaise and lost condition. But, following antibiotic treatment, it gained condition, despite a huge abscess in the frontal sinus. Such space occupancy should have killed the bull by itself and should have created clinical signs such as nystagmus, head pressing, hyperaesthesia and circling and yet this bull still mounted cows on heat. The report about mounting a cow one-hour before death is incredible considering the tremendous pressure on the brain, loss of granular layer neurons in the cerebellum and the degenerated testes.
Perhaps it may have been attributed to the resilience of the bull, if the report of the animal attendants was to be relied on.

The sudden death with tar-coloured blood that did not clot in this case underlined the fact that such symptoms are not restricted to anthrax. The extent of the multiple liver abscesses plus the damage to the frontal bone and brain were indicative of a chronic disease, which should have debilitated the bull but instead it remained in good body condition. Death was associated with septicaemia. There were two sources of bacteria, namely the liver abscess and frontal abscess. Those in the former were encapsulated and bland but those of the head were active, corroding the bone and causing cellulitis, and was the most likely source of infection.

Liver abscesses were multiple, and one was enormous in size and these are normally caused by haematogenous infection from ruminitis. Though the pathogenesis was slow, the disease must have contributed to the death due to poor liver function. The cause of the frontal abscess was not concluded. As stated earlier, frontal abscess in cattle is usually secondary to dehorning but this bull was not dehorned. One can only speculate that there might have occurred some lacerating traumatic injury and the wound healed. It was not possible to tell if a fracture existed because the bone had become soft like cartilage. The volume of pus which caused the ventral segment of the frontal bone to cave into a cone compressing the brain should have caused a bulge in the face or even ruptured to the surface, and yet the face was flat despite the softened bone. This suggested that the ventral segment was affected a long time before the dorsal segment softened. *Eishcherichia coli* was isolated from the pus collected from the frontal sinus.

The fact that there was no suppurative meningoencephalitis emphasises the point that the dura is indeed tough and epidural infections rarely reach the pia mater or brain parenchyma. The severest neurological damage was the destruction of the granular layer neurons and Purkinje cells of the cerebellum. This is because of their selective vulnerability to hypoxia caused by ischaemic compression of the brain by the lower segment frontal bone.

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Le Bulletin de la Santé et de la Production animales en Afrique contient des articles de recherches originales traitant d'activités en matière de santé et de production animales visant à assurer le développement de l'industrie animale et une meilleure utilisation des ressources du bétail en Afrique. Le Bulletin est un périodique trimestriel.

Présentation des articles
Deux exemplaires des articles doivent être adressés à Monsieur le Rédacteur en Chef, Bulletin de la Santé et de la Production Animales en Afrique, Organisation de l'Unité Africaine/Bureau interafricain des Ressources animales, P.O. Box 30786, Nairobi, Kenya


Un article ne peut être soumis pour publication que s'il n'a pas encore été proposé ailleurs, il fera l'objet de quelques modifications par le Comité de Rédaction.

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- des communications originales.
- des brèves communications.
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Les manuscrits doivent respecter les conditions suivantes: Le titre doit être concis et ne pas dépasser plus de 15 mots, il est suivi du (des) nom(s) de l'auteur (ou des auteurs) et des établissements où le travail a été effectué, ainsi que de l'adresse pour les correspondances si elle n'est pas la même.

Le résumé ne doit pas dépasser 200 mots. Son texte bref et concis comprendra les principaux résultats et la (les) conclusion(s) de l'étude.

L'introduction expose le but de la recherche.

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