GUIDANCE FOR AUTHORS

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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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Two copies of articles should be sent to the Editor, Organisation of African Unity/Interafrican Bureau for Animal Resources, P.O. Box 30786, Nairobi, Kenya.
Manuscripts should be in clear concise English or French, typewritten with double spacing and adequate margins. The spelling should be that of The Short Oxford English Dictionary or Le Petit Robert.
An article submitted for publication implies that its content has not been published elsewhere and that it is subject to editorial revision.

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- Full papers providing accounts of original work
- Short communications
- Review articles invited by the Editor
- Editorials
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- Book Reviews
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The manuscripts should contain the following features: Title; which should be concise, not more than 15 words long, followed by the author(s) name(s) and institutions to which work should be attributed and address for correspondence, if different.

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

Introduction stating the purpose of the work.
Materials and Methods used.
Results presented concisely.
Discussion of significance.
Acknowledgements.

References numbered consecutively in the order they are first mentioned in the text. Identification of references in the text should be by numbers (in parentheses) ad not by authors' names.
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A.N. MBISE, J.O. MOLLE L, E.J. KAAYA and P.N. SANKA,
Veterinary Investigation Centre, Northern Zone, P.O. Box 1068, Arusha

UNE EPIDEMIE DUE A UNE INFECTION PAR *PSEUDOMONAS AERUGINOSA* DANS UN COUVROI ET CHEZ DES JEUNES PONDEUSES AVEC DES TAUX DE MORTALITE ELEVES AU NORD DE LA TANZANIE

Résumé

Pendant la période allant d’avril à octobre 1997, l’infection par *Pseudomonas aeruginosa* a été diagnostiquée chez des jeunes pondeuses et dans un couvroit au nord de la Tanzanie avec des taux de mortalité très élevés: entre 50 et 100%. L’organisme semblait être responsable de l’un des maladies bactériennes infectieuses les plus importantes dans un couvroit de volailles. Il a été demandé à la ferme avicole concernée de respecter strictement les règles d’hygiène et les précautions sanitaires nécessaires à l’entretien d’un couvroit de volailles.

Summary

During the period extending from April to October 1997, *Pseudomonas (Ps.) aeruginosa* infection was diagnosed in young layer chicks and in a hatchery in northern Tanzania with very high mortalities of between 50–100%. The organism appeared to be one of the most important bacterial infectious disease in poultry hatchery. The farm concerned was requested to stick to strict hygiene and sanitary precautions necessary for a poultry hatchery.

Introduction

*Pseudomonas* is of increasing clinical importance as a result of its resistance to antibiotic therapy. It is a facultative pathogen, causing inflammation and bluegreen pus in a variety of animal species. Its presence in the animal body is mostly a flare up of a latent infection, such as an invasion of the intestinal mucosa or the rectum

Outside, the body *Pseudomonas aeruginosa* is encountered in water, soil, effluvium and has a worldwide distribution. When involved in mastitis it can become important in food hygiene with respect to untreated raw milk

When involved in mastitis it can become important in food hygiene with respect to untreated raw milk.

In poultry in Tanzania, *Pseudomonas* was isolated from incubated chicken eggs which failed to hatch. Rapid expansion of poultry industry, coupled with high stocking densities, have created conditions conducive to the spread of infectious diseases (including *Pseudomonas*) of poultry in this country. Since, there is no vaccine for pseudomonas infection in poultry and from the limitations of the effective antibiotics, the control of this disease largely rests on strict sanitary precautions in hatcheries.

This paper reports an outbreak of *Pseudoma aeruginosa* infection in a hatchery and in young layer chicks with very high mortalities, its possible control measures in hatcheries and treatment of young chicks.

Materials and Methods

Case history

In the period between April and October 1997, many young chick carcasses and moribund
chicks with similar signs from different poultry keepers in Arusha town and its vicinity were submitted to the centre for diagnosis. The affected chicks were layers aged between 1-14 days old. All chicks originated as one day old from a parent stock hatchery, situated about 30 kilometers east of Arusha town. Following these complaints, the parent stock hatchery was visited twice during the same period and different samples for bacteriological examination collected, viz. faecal swabs from the hatchery, drainage material from the hatchery, drinking water, trough water from the hatchery, swabs from the outer part of the egg shell from the later parent stock house, eggs (which did not hatch), shells and embryos. Almost all poultry keepers, who had similar problems were visited in order to ascertain their brooding management.

Bacteriological Examination
The clinical specimens of choice were yolk sac, liver, heart, lungs and spleen from the submitted carcases.

Each sample, including those collected from the hatchery, was streaked on MacConkey agar, nutrient agar and on blood agar within six hours of collection and incubated at 37°C overnight, 24 hours and 48 hours aerobically. After isolation Pseudomonas aeruginosa was characterised using the information on colonial, cellular and biochemical characteristics as well as the combination as follows: tendency to localised swarming from the edge of the colonies; pigmentation; characteristic smell (fruity); presence of shiny metallic patches on the surface of the colonies.

Results
Seven poultry keepers were visited and the constant clinical signs observed were: Many chicks appeared normal until a few hours before death; Depression, drooping of the head, huddling near the source of light, very high mortalities. The following lesions could be observed in most carcases: haemorrhagic pneumonia, some carcases (especially day old chicks) had inflamed navel and sometimes a scab was found present. All the chicks had unabsorbed highly congested yolk sac and pericarditis.

A total of 4 pure cultures of Pseudomonas aeruginosa isolates were obtained from reported cases. Another 6 bacterial cultures had a mixture of coliforms and Pseudomonas. Specimen collected from the hatchery revealed the following bacteria: faecal swabs = Coliforms; drainage material = Coliforms; drinking water = no growth of pathogen; trough water = Pseudomonas swabs from the outer part of the egg shell from the layer parent stock house Coliforms; unhatched eggs = Pseudomonas sp. and Coliforms; 4 embryos = Pseudomonas sp. and 2 sick 3 day old chicks from the brooder = Pseudomonas spp.

(Note: After these complaints, the owners of the hatchery were compelled to perform brooding management like how their clients do. Our main interest was the non lactose fermentative bacteria. Many colonies were pitted. These organisms grew fast at 37°C overnight, 24 hours and 48 hours, aerobically. Formation of the blue green pigment pyocyanin after 48 hours at 37°C on nutrient agar was evident. Biochemical characterisation revealed the organism to be positive to catalase, oxidase, gelatinase production, urease production, arginine dihydrolase production and glucose fermentation but negative to lactose production, maltose production, lysine decarboxylase production and ornithine decarboxylase production. All isolates were motile and there was no growth at 5°C.

The organism was identified as Pseudomonas aeruginosa.

Discussion
During the present study, Pseudomonas aeruginosa was not the only bacteria which was isolated, also Coliforms were isolated. However, E. coli has been isolated in young chicks for many years but had never had such high mortalities as we experienced this time. Since the main isolates from many carcasses were pure cultures of Pseudomonas aeruginosa and that the same bacteria, Pseudomonas aeruginosa was
An analysis of treatment schedule of these outbreaks revealed that common drugs (e.g. oxytetracycline powder, 20% sulfonamides, etc) used in pseudomonas infections did not check the mortalities. As regards the availability of effective antibiotics\(^ {24} \) gentamycin and neomycin had total effectiveness while kanamycin and polymyxin B were slightly effective. Also, the antibiotic carbenicillin (pyopen) on its own, or in combination with gentamicin was found to be effective against these bacteria\(^ {24} \). Oral administration of an organic iodine compound and vaccination with a killed autogeneous vaccine brought the disease under control in one herd. It remains to be known if such a vaccine for chicks can locally or commercially be realised.

However, drug resistance was not proved in this study. Because of these limitations of chemotherapy, the hatchery owners were advised to think of alternative methods for controlling infections with the organism as has been suggested above.

It is concluded from the present study that it is more useful to eradicate the organism from the environment to avoid the organism contaminating the hatchery than treating young chicks and to stick to strict hygiene and sanitary precautions necessary for a poultry hatchery.

Acknowledgement

The authors are grateful to Prof. U. M. Minga of the Sokoine University of Agriculture (SUA) Morogoro and Dr. B. Lema of Animal Disease Research Institute (ADRI), Dar es Salaam for confirming some of our bacterial isolates as Pseudomonas. This paper is published with the permission of Director of Veterinary Services, Ministry of Agriculture and Cooperatives, Dar es Salaam.

References


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AN OUTBREAK OF ULCERATIVE ENTERITIS (QUAIL DISEASE) IN A FLOCK OF COCKERELS

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UNE ÉPIDÉMIE D'ENTERITE ULCÉRATIVE ("MALADIE DE LA CAILLE") CHEZ UNE BANDE DE COQUELETS

Résumé

Une épidémie d'enterite ulcéратive ("maladie de la caille") chez une bande de coquelets a été signalée. La maladie était caractérisée par un accroissement de la mortalité de 20% et par des lésions dans le tractus intestinal, le foie et la rate. Les lésions dans le tractus intestinal consistaient en des ulcérations jaunâtres de tout le tractus, visibles à partir de la surface sèche. Sur la surface muqueuse, les ulcères consistaient en des dépressions centrales couvertes par une matière nécrotique brunâtre. Les lésions dans le foie et la rate consistaient en des foyers nécrotiques. L'organisme causal: Clostridium colinum était isolé des prélevements de foie.

Selon ce rapport, l'enterite ulcéратive peut être une cause majeure de mortalité chez les poulets au Kenya et elle pourrait être considérée comme une coccidiose par erreur de diagnostic.

Summary

An outbreak of ulcerative enteritis ("Quail disease") in a flock of cockerels is reported. The disease was characterised by an increasing mortality of up 20% and lesions in the intestinal tract, the liver and the spleen. Lesions in the intestinal tract consisted of yellowish-white ulcerations of the entire tract visible from the serosal surface. On the mucosal surface the ulcers consisted of central depressions covered by a brownish necrotic material. Lesions in the liver and spleen consisted of necrotic foci. The causative organism, Clostridium colinum, was isolated from liver samples.

This report indicates that Ulcerative enteritis (UE) can be an important cause of mortality in chickens in Kenya and which may be misdiagnosed as coccidiosis.

Introduction

Ulcerative enteritis is an acute or subacute disease caused by a bacterial organism Clostridium colinum\(^1\,^2\,^3\). The disease was originally associated with wild birds especially quails but now known to affect many other species of birds including the domestic poultry\(^4\,^5\,^6\). Clinically the disease is characterised by an increasing sudden death with mortality of up to 15%, apathy and a drop in egg production in a laying flock\(^6\) while pathological lesions include ulcerative enteritis and necrosis in the liver and spleen. The causative agent can be obtained from heart blood and tissues of birds soon after death. This report concerns an outbreak of the disease in a flock of cockerels.

Materials and Methods

Case history

The outbreak involved a flock of 700 "improved" cockerels age 2 months belonging to the National Poultry Development Programme at Karai, Kiambu District in Kenya. The cockerels were being raised for sale to farmers wishing to improve their indigenous flocks. Carcasses of birds with a history of depression before death were submitted to the department of Pathology and Microbiology, University of Nairobi for postmortem examination. Also submitted on request were the daily mortality figures since the onset of the disease. The mortality increased gradually to a peak of 6.2% by day seven before dropping to zero by day 13 (Figure 1). The overall mortality was 19.7%.
Adjacent cells exhibited coagulative necrosis with karyolysis and karyorrhexis. There was also mononuclear infiltrations in areas adjacent to the ulcers. Blood vessels in the submucosa showed degeneration of the endothelium. The liver had clearly delineated foci of coagulative necrosis scattered throughout the parenchyma with little or no inflammatory cells infiltration. In the spleen the necrotic foci consisted of irregular areas of pink-staining necrotic material also scattered throughout the parenchyma.

**Bacteriological isolation**

Liver samples were homogenised in a mortar and pestle and sterile sand. The homogenate was heated in a waterbath at 80°C for 10 min and then inoculated into thioglycolate broth containing 10% horse serum. After incubation at 37°C for 24 hrs smears of the cultures were made, Gram-stained and examined. Gram positive slightly curved rods with cylindrical subterminal spores were observed.

**Diagnosis**

On the basis of clinical history of sudden deaths and an increasing mortality together with the gross and microscopic lesions and bacteriological analysis a diagnosis of Ulcerative Enteritis was made. An important differential diagnosis was coccidiosis on the basis of intestinal ulceration.

**Discussion**

The case presented indicates that Ulcerative enteritis (UE) can be an important cause of mortality in chickens in Kenya. This is the first report of the disease in the country. A total mortality of about 20% was higher than the reported 2-15% reported elsewhere probably due to the young age of the birds. The mortality rate was comparable to that observed in Infectious Bursal Disease in the country. The fact that EU has not been widely reported in the country probably indicates the extent to which it is misdiagnosed as coccidiosis. Both coccidiosis and UE frequently occur together and the former
may predispose chickens to the latter[?]. It is therefore concluded that antibacterial therapy should be instituted in cases diagnosed as coccidiosis that are refractory to treatment.

References

Received for publication on 8th October, 1996
SURVEY OF TICK TRANSMITTED HAEMOPARASITES OF SHEEP AND GOATS IN THE GUINEA SAVANNA OF NIGERIA

A.D. DANIEL, *R.A. JOSHUA, J.O. KALEJAIYE and A.J. DADAH,
Nigerian Institute for Trypanosomiasis Research, Vom Plateau State, Nigeria
*Department of Veterinary Medicine, University of Ibadan, Ibadan, Nigeria

ENQUETE SUR LES HEMOPARASITES TRANSMIS PAR LES TIQUES CHEZ LES MOUTONS ET LES CHEVRES DANS LA SAVANE GUINEENNE DU NIGERIA

Résumé
Six cent quinze prélèvements de sang recueillis des moutons et des chèvres dans neuf villages de l'Etat de Bauchi au Nigeria ont été examinés pour dépister les infections des hémoparasites transmis par les tiques à l'aide de minces frottis colorés de Gimsa. L'hémoglobine (Hb) a été déterminée avec la spectrophotométrie à l'aide de la méthode de l'hématine d'acide et la numération des hématies (H) et des leucocytes (L) était effectuée avec la cellule de Neubauer améliorée.

15,5% étaient infectés avec les espèces Anaplasma et Babesia L'infection avec A. ovis et B. ovis était la même chez les moutons: 7,4%, alors que l'infection avec A. ovis et B. motasi était respectivement de 9,8% et 6,2% chez les chèvres.

Le taux global d'infection n'a pas révélé une différence significative (P > 0,05) entre les races et les sexes pour les deux infections. L'anémie était plus accentuée chez les animaux infectés que chez les indemnes, puisqu'elle était associée à une valeur plus réduite de l'hématocrite, de l'hémoglobine et de l'hématie.

Summary
Six hundred and fifteen blood samples collected from sheep and goats in nine villages in Bauchi State, Nigeria were screened for tick transmitted haemoparasites infections using Giemsa's stain thin smears. Haemoglobin (Hb) was determined spectrophotometrically by the acid hematin method, and red blood cells (RBC) and white blood cells (WBC) counts were made by an improved Neubauer chamber.

15.5% were infected with Anaplasma and Babesia species. A. ovis and B. ovis equally accounted for 7.4% in sheep, while A. ovis and B. motasi accounted for 9.8% and 6.2% in goats respectively.

The overall infection rate do not reveal a significance difference (p > 0.05) between breeds and sexes in both infections. Anaemia was more severe in infected than uninfected animals as this was associated with lower packed cell volume (PCV), Haemoglobin (Hb) and RBC counts.

Introduction
Apart from work by Opasina and Smith(1,2), there is paucity of information on natural tick transmitted haemoparasites of sheep and goats in Nigeria.

Anaplasmosi is and Babesiosis have been reported in cattle in most parts of the world(3-8) and Africa(9,10) to be of economic importance. These diseases affect cattle(3,6,9) and other ruminants like antelope, buffalo, camel, deer(11-13), elk, sheep and goats(9,10,14). Non-ruminants and laboratory animals and man are not susceptible(9,11).

Numerous arthropods like horseflies, stable fly and mosquitoes have been shown experimentally to be capable of transmitting the diseases in nature(15,17). Mechanical transmission by biting flies such as black flies, hornflies(8,17) and contamination of surgical and bleeding needles is possible(7,15).
With the high cost of beef and poultry feeds, sheep and goats are commonly kept under backyard production\textsuperscript{(18,24)}. Because of their socio-economic importance, they are kept in both urban and rural households in Nigeria. It has been estimated that there are 21.8 and 33.9 million sheep and goats respectively in Nigeria\textsuperscript{(14,21,24)}, which accounted for about 35\% of the total meat supply\textsuperscript{(24)}.

The productivity and potentials of sheep and goats depend on the breed and its adaptability to the site of production.

Because of the economic importance of these diseases in the livestock industries in many parts of the tropical and subtropical zones, there is the need to ascertain the diseases under natural field conditions.

This paper presents findings on the prevalence of these diseases under natural field situation, obtained from the use of comprehensive survey of sheep and goats.

**Materials and Methods**

**Study area**

The survey was conducted in Bauchi state of Nigeria in nine villages from April to July, 1991.

The villages lie at longitude 8°15’S and latitude 6°10’N in the Guinea vegetation zone. The mean annual rainfall is 300 mm and the area supports abundant wild animals because of the nearness of Yankari Game Reserve.

**Sheep and Goats**

The breeds of sheep in this area of study are Uda, Yankasa and their crosses. The breeds of goats are the sahelian and their crosses.

Under the traditional Fulani agropastoral system, sheep and goats are grazed along with cattle. At the end of the day, sheep are tied using neck loops to another rope tied between pickets. Goats are usually tethered under shelter and fed with silage especially during the rainy season. They regain their freedom during the dry season to feed by themselves.

The flock structures showed that females accounted for 82.1\% and 77.4\% in sheep and goats respectively, giving female to male ratios of 3.5:1 for sheep and 3.7:1 for goats. A total of 615 animals were bled comprising of 258 and 357 sheep and goats respectively.

**Examination of parasites**

About 5 ml of blood was collected from the jugular vein of each animal into EDTA contained Lijou bottles. The bottles were labelled serially and the breed and sex of the animals bled indicated.

Thin blood smears were made from each sample on slides and stained using 10\% Giemsa in phosphate saline at pH 7.2\textsuperscript{(39)}. Microscopical examination of the blood films were used to determine the parasitaemia. At least four hundred red cells were examined on each slide under an oil immersion objective (x100) and the number of parasitized cells recorded. The counting of the infected and non-infected cells was facilitated by using the technique described by Wintrobe\textsuperscript{(18)}. Packed cell volume (PCV) was determine by the microhaematocrit method\textsuperscript{(18)}.

Haemoglobin (Hb) was determined spectrophotometrically by the acid hematin method, and the RBC and WBC counts were made by an improved Neubauer Chamber using a 1x10\textsuperscript{8} counting dilution\textsuperscript{(27)}.

The mean values and standard deviation of haematological parameters for the various age group, breed and sex were determined. Results were interpreted by carrying out analysis of variance and student t-test, in order to obtain the level of significance (p).

**Results**

The results of the survey are shown in tables 1, 2, 3 and 4.
### Table 1: Haemoparasites infection in sheep and goats

<table>
<thead>
<tr>
<th></th>
<th>No. sampled</th>
<th>Babesia +ve</th>
<th>Anaplasa +ve</th>
<th>Total (%)</th>
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</thead>
<tbody>
<tr>
<td><strong>Sheep</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>75</td>
<td>6</td>
<td>12</td>
<td>18 (24.0)</td>
</tr>
<tr>
<td>Female</td>
<td>183</td>
<td>13</td>
<td>7</td>
<td>20 (10.9)</td>
</tr>
<tr>
<td>Total</td>
<td>258</td>
<td>19 (7.4)</td>
<td>19 (7.4)</td>
<td>38 (14.7)</td>
</tr>
<tr>
<td><strong>Goats</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>75</td>
<td>8</td>
<td>11</td>
<td>19 (25.3)</td>
</tr>
<tr>
<td>Female</td>
<td>282</td>
<td>14</td>
<td>24</td>
<td>38 (13.4)</td>
</tr>
<tr>
<td>Total</td>
<td>357</td>
<td>22 (6.2)</td>
<td>35 (9.8)</td>
<td>57 (16.0)</td>
</tr>
<tr>
<td><strong>Grand total</strong></td>
<td>615</td>
<td>41 (6.7)</td>
<td>54 (8.7)</td>
<td>95 (15.5)</td>
</tr>
</tbody>
</table>

### Table 2: Distribution of haemoparasites encountered in the nine villages

<table>
<thead>
<tr>
<th>Villages</th>
<th>No. Sampled</th>
<th>Babesia (+ve)</th>
<th>Anaplasma (+ve)</th>
<th>No. sampled</th>
<th>Babesia (+ve)</th>
<th>Anaplasma (+Ve)</th>
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<tr>
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<td>42</td>
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<tr>
<td>Dugari</td>
<td>13</td>
<td>2</td>
<td>-</td>
<td>49</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Mallari</td>
<td>14</td>
<td>-</td>
<td>1</td>
<td>72</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Dukul</td>
<td>33</td>
<td>2</td>
<td>4</td>
<td>41</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Mallam</td>
<td>32</td>
<td>3</td>
<td>2</td>
<td>21</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Dodo</td>
<td>46</td>
<td>5</td>
<td>4</td>
<td>34</td>
<td>2</td>
<td>5</td>
</tr>
</tbody>
</table>

| 258        | 19 (7.4)    | 19 (7.4)     | 357            | 22 (6.2)    | 35 (9.8)     |

### Table 3: Mean PCV ± S.D. of the infected and uninfected sheep and goats with *Anaplasma* and *Babesia* species at various age groups

<table>
<thead>
<tr>
<th>Ages</th>
<th>MEan PCV±Sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young animals (3-12 months old)</td>
<td></td>
</tr>
<tr>
<td>Sheep uninfected</td>
<td>35±2.1</td>
</tr>
<tr>
<td>Sheep Infected</td>
<td>34±2.3</td>
</tr>
<tr>
<td>Uninfected goats</td>
<td>33±1.6</td>
</tr>
<tr>
<td>Infected goats</td>
<td>30±1.1</td>
</tr>
</tbody>
</table>
Table 4: Differential blood count of both uninfected and infected sheep and goats

<table>
<thead>
<tr>
<th></th>
<th>Uninfected</th>
<th>Infected</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sheep</td>
<td>Goats</td>
</tr>
<tr>
<td>RBC x10^6/μl</td>
<td>8.5 ± 1.8</td>
<td>8.0 ± 2.0</td>
</tr>
<tr>
<td>PCV (%)</td>
<td>32.4 ± 1.8</td>
<td>29.5 ± 1.4</td>
</tr>
<tr>
<td>Haemoglobin</td>
<td>10.0</td>
<td>9.0</td>
</tr>
<tr>
<td>EBC (1pt x10^6)</td>
<td>4.3</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Out of a total number of 615 animals examined, 95 (15.5%) were infected with *Anaplasma* and *Babesia* species. *Anaplasma ovis* and *Babesia ovis* accounted equally for 19 (7.4%) in sheep, *Anaplasma ovis* and *Babesia motasi* accounted for 35 (9.8%) and 22 (6.2%) in goats respectively (Table 1). The table also shows the distribution of infections based on the breed and sex.

The distribution of infections encountered in the nine villages is outlined in Table 2. *Anaplasma* infection was encountered more than that by *Babesia* in goats in the nine villages surveyed.

The overall infection rate does not reveal a significance difference (P > 0.05) between breeds and sexes in both infections (Table 1). But there is a significant difference (P < 0.05) between the mean PCV of the infected and uninfected sheep and goats (Table 3).

The mean differential blood count of both uninfected and infected sheep and goats are indicated in Table 4.

**Discussion**

The findings of this survey have extended the observation that *Anaplasma* and *Babesia* infections occur naturally in domestic sheep and goats. The overall infection rate of 15.5% for both infections suggests that they should be taken seriously in sheep and goats. Mixed infection of both *Babesia* and *Anaplasma* were encountered during the survey as first observed by Seddon[71].

The diseases are more severe in adult sheep and goats than in the young ones. This is in line with the observation in cattle by Christensen, Jones et al and Jones Brook[94]. The lower PCV of the infected sheep and goats compared to that of lambs and kids indicates the severity of anaemia (Table 3). The anaemia may be due to the accelerated removal of red blood cells by macrophages and not by bone marrow depression. This is because the differential blood count shows low RBC and Haemoglobin counts in the infected sheep and goats[4] coupled with the fact that no immature forms were observed. The maximal infection observed was greatest in adult sheep and goats. Despite this there was relatively small difference between the resulting intensities of anaemia in the various groups (Table 3). This might be due to different clearance rates of infected RBC and variation in the number of non-infective RBC.

The overall infection rate does not show a significant difference (P > 0.05) between breeds and sexes. This might be because ecological factors which include terrain, vegetation and geographical distribution in their natural environment might have profound influences on the epidemiology of the disease.

It is not surprising to observe that infection was higher in July when the tick population was high. This is because the distribution of the causative protozoa is governed by geographical distribution of the tick vector and their ability to transmit them[13, 18].

The overall infection rate could have been higher for it is believed that permanent infection occurs after repeated natural infections. Christensen[11] was able to detect antib
calves for 150-170 days, which suggest that the low infection observed in young sheep and goats may be due to acquired antibodies from their mothers. Ajayi[9] observed experimentally animals on a high nutritional plane were more severely affected than those on a low plane of nutrition, but they recovered more rapidly than the later.

Since this animals are not kept under intensive management they are prone to infections, hence there is the need to include them in any chemotherapeutic or chemopro-phylactic treatment considering the fact that they are grazed alongside the more economically regarded cattle population in this area.

From this study tick-borne diseases in sheep and goats are of economic importance in view of the fact that they contribute 35% of the meat supply in Nigeria[10]. With good genetic engineering both local and imported sheep and goats can be made resistant to some extent to ticks thus enabling them to express their full potential as a source of meat to the ever growing population.

Acknowledgement

We wish to thank the following members of staff or their invaluable help during the survey:- Messrs Jacob A. Ayandele, Sabo Garba and Francis Doro and also Prof. G.O. Esuruoso of the Dept. of Vet, Public Health and Preventive Medicine, University of Ibadan for allowing me access to his lab. Finally the Director, N.I.T.R., Dr. I. Halid for permission to publish.

References


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THE PREVALENCE AND INTENSITY OF INFECTION WITH FASCIOLA GIGANTICA IN CATTLE IN KIAMBU DISTRICT, KENYA

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PREVALENCE ET INTENSITE DE L’INFECTION AVEC FASCIOLA GIGANTICA CHEZ LES BOVINS DANS LE DISTRICT DE KIAMBU AU KENYA

Résumé
La prévalence et le nombre d’œufs de douve du foie par gramme de féces (EPG) dans les prélèvements fécaux des petits (moins de 6 mois), des jeunes (6-12 mois) et des adultes (plus de 12 mois) dans 16 fermes du District de Kiambu étaient étudiés pendant la saison sèche et la saison pluvieuse. La proportion d’animaux qui répandaient des œufs de douve du foie ne variait pas beaucoup avec la saison. La prévalence des œufs était beaucoup plus élevée (P < 0,05) chez les bovins adultes (68,3% en moyenne) que chez les jeunes et les petits. Les jeunes bovins avaient une prévalence d’œufs beaucoup plus forte (24,1% en moyenne) que les petits (une moyenne de 9,7%). Les nombres d’œufs de douve par gramme de féces (EPG) étaient beaucoup plus élevés chez les bovins adultes et les jeunes par rapport aux petits pendant les deux saisons, mais ils n’étaient pas très différents entre les jeunes et les adultes. Il n’y avait pas de différence significative quant aux EPG durant la saison sèche (moyenne géométrique: 485) par rapport à la saison pluvieuse (moyenne géométrique: 527). Le sexe des animaux n’avait pas d’effets notables sur la prévalence ou l’EPG. 436 bovins abattus dans divers abattoirs pendant la période de l’enquête étaient examinés pour dépister les infections par les douves du foie et de l’estomac. Les taux de prévalence des infections avec Fasciola gigantica et Calicophoron microbothrium étaient respectivement de 42,5% et 53,9% pendant la saison sèche et de 35,5% et 59,6% pendant la saison des pluies. La sensibilisation accrue sur la distomatose, l’utilisation massive des anthelminthiques et l’application d’autres mesures de lutte ont eu peu d’effets sur les taux de prévalence des infections dans la zone couverte par la présente étude.

Summary
The prevalence and the number of liver fluke egg counts per gram of faeces (EPG) in faecal samples from young (less than 6 months old), immature (6-12 months old) and adult (over 12 months old) cattle on 16 farms in Kiambu District were studied during the dry and wet seasons. The proportion of animals shedding liver fluke eggs did not vary significantly with season. The prevalence of the eggs was significantly higher (p < 0.05) in adults (mean 68.3%) compared to immatures and young calves. Immature animals had a significantly higher egg prevalence (mean 24.1%) compared to the young calves (mean 9.7%). EPG counts were significantly higher in immature and adult cattle compared to young calves during both seasons, but were not significantly different between immature and adult cattle. There was no significant difference in EPG during the dry season (geometric mean 485) compared to the wet season (geometric mean 527). The sex of the animals had no significant effect on prevalence or EPG. Four hundred thirty six cattle slaughtered in various slaughter houses/slabs during the survey period were examined for evidence of liver and stomach fluke infections. The prevalence rates of Fasciola gigantica and Calicophoron microbothrium infections were respectively 42.5% and 53.9% during the dry season and 35.5% and 59.6% during the wet season. The increased awareness of fasciolosis, massive increase in the use of anthelmintics and the development of other control measures appear to have made little impact on the prevalence rates of infection in the current study area.
Introduction

Liver fluke disease is of cosmopolitan occurrence and is caused by *Fasciola hepatica* in the temperate zones and *F. gigantica* in the tropics. Extensive studies on the prevalence of fasciolosis due to *F. gigantica* have been carried out in various parts of tropical Africa and include those by Coyle, Hammond, Bitakaramire, Megard, Mzemba and Chaudhry, Ogurinade and Tembely. In Africa, Megard quoted prevalence rates of 37% for Sudan, Cameroon (45%), Ethiopia (30-90%), Uganda (16%), Central African Republic (62%), Rwanda (50%) and Tanzania (4%). The prevalence rates in Kenya vary from less than 10% in arid and semi-arid zones to over 40% in high potential areas which have a high density of livestock and high rainfall suitable for the survival and breeding of the snail intermediate host.

Two forms of the disease reportedly occur in Kenya. The acute form is mainly seen in calves and results from traumatic hepatitis following a massive invasion of the liver by young flukes. This results in the destruction of the liver parenchyma and haemorrhages, with death occurring within 48 hours. Chronic fasciolosis is however, the more prevalent and is associated with the presence of adult *F. gigantica* in the bile ducts. The disease is usually a debilitating process leading to gradual loss of condition, progressive weakness, anaemia and hypoproteinaemia. At necropsy, there are markedly thickened and distended bile ducts packed with adult flukes. These bile ducts later calcify to produce what resembles a branching system of clay pipes.

The economic losses caused by fasciolosis can be very serious, particularly when the local environmental conditions are conducive for the high and persistent rate of transmission. In such situations animals are often exposed to large doses of infection, sometimes taking the form of outbreaks of the acute disease with high mortalities especially in small ruminants and young cattle. However, of even greater overall economic importance are the less dramatic but insidious, long term and deleterious effects of the chronic wasting condition. Fasciolosis does affect the reproductive performance of farm animals by way of reducing the potential breeding performance by impairing the growth rate of young stock, the attainment of puberty in heifers and through the prolongation of oestrus in mature animals. In addition, condemnation of infected livers at meat inspection results in a considerable loss of revenue.

Diseases caused by liver flukes (*Fasciola*) and gastrointestinal or stomach flukes (*Paramphistomes*) result in major economic losses in cattle, buffaloes, sheep and goats. It is estimated that more than 300 million bovines and 250 million sheep are exposed to these parasites worldwide, causing economic losses amounting to more than US$3 billion per year. Economic losses in cattle attributed to fasciolosis in Kenya have been estimated to Ksh. 326 million per year. The overall effect to the livestock industry is therefore much higher since the above figure excluded losses in small ruminants.

This present study documents the prevalence and intensity of liver fluke infection in dairy cattle in Kiambu District, Kenya. Information was also obtained on the relationships of age, sex and season with prevalence. This information could be useful towards understanding the epidemiology of fasciolosis in Kenya, a necessary step for selection and effective application of control strategies.

Materials and methods

Study area

Kiambu District is situated in Central Province, in the highlands of Kenya and lies within an altitude of between 1500m and 3200m above sea level. Geographically, the area is a dissected plateau with abundant slow flowing water systems and stagnant water masses during the wet season. Some of these persist even during the dry season thus creating conditions favorable for habitation by fresh water snail populations of
Veterinary importance. The district experiences bimodal rainfall of between 750mm and 500mm annually. The long rains occur between March and May, and the short rains between October and December. The mean monthly minimum temperature varies from \(10^\circ\text{C}\) to \(15^\circ\text{C}\) and the mean maximum temperature from \(20^\circ\text{C}\) to \(25^\circ\text{C}\).

Due to the high population density, most of the district has been cleared of natural vegetation to give way to farming practices. Most of the residents are small holder mixed farmers and the livestock enterprise is mainly for milk production. The cattle population of about 60,000 heads is comprised mainly of dairy cross breeds of Friesian, Guernsey and Ayrshire escents. Zebu cattle are also found in parts of Limuru and Juja Divisions.

Experimental design

The survey was conducted on 6 large (>30 animals) and 10 small (<20) small scale farms randomly distributed within the 7 divisions of the district. Samples were collected during the month of September 1991 (dry season) and May 1992 (wet season). Three age groups of cattle (young, less than 6 month of age; immature, 6-12 months old; and adults, over 12 months old) were selected on each farm. Ten to twelve animals were chosen at random and sampled. Faeces were collected directly from the rectum of each animal, placed in labelled plastic containers and stored at \(4^\circ\text{C}\) until examined.

A sedimentation technique as described by Hansen and Perry was used to detect the presence of liver fluke eggs in the samples. Data on monthly precipitation was obtained from meteorological sub-stations nearest to the farms.

A total of 436 adult cattle of mixed breeds and sexes were selected at various abattoirs and slaughter slabs, and examined post-mortem during the sampling periods. Attempts were made to determine the origin of the animals by abattoir location. Following slaughter of the animals, each liver was examined by cutting through the thin lobe and through the bile ducts to determine the presence or absence of *F. gigantica*. The rumen and reticulum were examined for the presence of adult paramphistomes as described by MAFF.

Statistical analysis

EPG counts were log-transformed (\(\ln (x + 1)\)) and examined by analysis of variance and where appropriate the differences between means being tested for significance using a Tukey’s test. A value of \(P<0.05\) was considered significant. The prevalence was defined as the percentage of faecal samples containing liver fluke eggs or cases found positive for adult liver and/or stomach flukes.

Results

The prevalence rates for different age groups of cattle are presented in Table 1. Of the 165 samples examined during the dry and wet seasons, 56 (33.9%) and 53 (32.1%) respectively, were positive for liver flukes. The prevalence of the liver fluke eggs were significantly higher \((p<0.05)\) in adult cattle compared with either the immature or young calves in both seasons. There were significant differences \((p<0.05)\) in the prevalence of egg counts between immature (24.1%) and young calves (9.7%), but there were no any significant differences between the seasons in the proportion of animals infected within each age group. Overall, the proportion of females (36.0%) and males (28.5%) shedding liver fluke eggs were not statistically different.

Table 2 shows the geometric mean EPG levels. Immature and adult cattle had significantly higher \((p<0.05)\) EPG than the young calves in both seasons. EPG did not differ significantly between immature and adult cattle; male and females; nor was there any significant difference in EPG between the dry and wet seasons.
Table 1: The prevalence of liver fluke eggs in faecal samples from young (under 6 months), immatures (6-12 months old) and adult (over 12 months old) cattle on 16 farms in Kiambu district during the dry and wet seasons

<table>
<thead>
<tr>
<th>Season</th>
<th>Under 6 months</th>
<th>6-12 months</th>
<th>Over 12 months</th>
<th>Females</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td><em>No.</em></td>
<td>INF(%)</td>
<td><em>No.</em></td>
<td>INF(%)</td>
<td><em>No.</em></td>
</tr>
<tr>
<td>Dry</td>
<td>57</td>
<td>6 (10.5)</td>
<td>56</td>
<td>13 (23.2)</td>
<td>52</td>
</tr>
<tr>
<td>Wet</td>
<td>57</td>
<td>5 (8.8)</td>
<td>56</td>
<td>14 (25.0)</td>
<td>52</td>
</tr>
</tbody>
</table>

*No = Number of samples examined, INF = Number (and percentage) of samples diagnosed positive.

Table 2: Geometric mean liver fluke eggs for male, females, young, immatures and adult cattle on 16 farms in Kiambu district during the dry and wet seasons

<table>
<thead>
<tr>
<th>Geometric mean eggs per gram (egp) of faeces (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Season</td>
</tr>
<tr>
<td>Dry</td>
</tr>
<tr>
<td>(0.1874)</td>
</tr>
<tr>
<td>Wet</td>
</tr>
<tr>
<td>(0.2022)</td>
</tr>
</tbody>
</table>

Data with the same letter (a, b, c, or d) are significantly different.

Table 3: The prevalence of *F. gigantica* and *C. microbothrium* in slaughtered cattle from Kiambu District during the dry and wet seasons

<table>
<thead>
<tr>
<th><em>Fasciola gigantica</em></th>
<th><em>Calicophoron microbothrium</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Season</td>
<td>Females</td>
</tr>
<tr>
<td>----------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Dry</td>
<td><em>No.</em></td>
</tr>
<tr>
<td>Dry</td>
<td>122</td>
</tr>
<tr>
<td>(45.1)</td>
<td>(39.2)</td>
</tr>
<tr>
<td>Wet</td>
<td>99</td>
</tr>
<tr>
<td>(37.4)</td>
<td>(33.9)</td>
</tr>
<tr>
<td>Overall prevalence</td>
<td>221</td>
</tr>
<tr>
<td>(41.6)</td>
<td>(36.3)</td>
</tr>
</tbody>
</table>

*No = Number of cattle examined, INF = Number and percentage of cattle infected

The prevalence rates of liver and stomach flukes observed from various slaughter houses and slabs are shown in Table 3. Of the 436 cattle lives examined, 39.0% were infected with *F. gigantica*. The mean overall difference between the dry (42.5%) and wet (35.5%) seasons was not of any statistical significance. The overall prevalence in females and males was 41.6% and 36.6%, respectively, showing that there were no significant differences between sexes. Paramphistome flukes were observed from rumino-reticular sacs of 59.6% of cattle during the course of the abattoir survey. The mean overall prevalence did not differ
significantly between females (59.6%) and males (60.1%), nor was there any significant differences between the dry (53.9%) and wet (65.4%) seasons (Table 3). Morphological examination of over fifty flukes showed that they all conformed to the description of *C. microbothrium*, as given by Horak(35).

**Discussion**

The current survey has shown that liver fluke infections are widespread in Kiambu District. This is in accordance with observations made by Mango and others(36), that fasciolosis in Kenya mainly affected cattle and was caused by *F. gigantica*(37), with an overall prevalence in slaughtered cattle being 17.0%, but only 1.6% in sheep and 1.1% in goats. Fasciolosis was most common in cattle in Central Province, with a prevalence of 41.5%(38). This prevalence was comparable with the overall prevalence of 39.0% in the current abattoir survey and 34.0% obtained in faecal examination for liver fluke eggs. Cheruiyot(11) also reported that bovine fasciolosis was endemic and of high prevalence in the high rainfall and high altitude areas of Kenya.

One of the important factors in the distribution of fasciolosis is the presence of the snail hosts. Brown(10) showed that *L. natalensis*, the snail host of *F. gigantica* in Kenya has a limited distribution but is widespread in Central province. Production losses are particularly high in areas with a network of slow flowing perennial streams, the favourite habitats of the snail vectors as is the case in many farms surveyed in the current study(10). In the high rainfall areas, as in some parts of Kiambu District, which is typical of the enzootic fasciolosis areas of Kenya, Preston and Castelino(24) reported that *L. natalensis* capable of shedding *F. gigantica* cercariae were present all times of the year, with the greatest increase in numbers occurring during the rainy season. This may explain the lack of significant seasonal fluctuations in prevalence or intensity of infection in the current study. Another possible factor that may influence the reported prevalence is the density of susceptible hosts. The bovine census of 1979(11), showed that the areas noted for snails and the disease are the same areas that have the highest numbers of cattle per unit area. The conditions then that permit the perpetuation of fasciolosis seem to occur simultaneously. Prevalence rates of liver flukes were highest in adult cattle than in either immature or young calves as earlier reported(38,39). It is reasonable to speculate that prevalence increased with age because of the longer period that animals are exposed to infected pastures and give also some support to the postulation that *F. gigantica* infections are not well and as rapidly expelled as *F. hepatica* infections(21).

The sex of cattle did not influence the prevalence of liver fluke infection in the current study. This was in contrast with earlier reports where incidence in females was generally higher than in males(40). However, in other studies, low prevalence in females of all ages was recorded, while there was an increase in prevalence in males with age(39).

*C. microbothrium* was found in 59.6% of the animals examined in slaughter houses and during post-mortem examination on cattle, not included in this study. This trematode was usually found in large numbers in the rumen but no clinical signs as described by Horak and Clark(41) could be attributed to this parasite. It has been known that stomach flukes are extremely common in Kenya although little is known about their pathological significance(42,43,44). Intestinal paramphistomosis causes substantial losses in cattle. Considerable mortality caused by *C. microbothrium* have been recorded in Kenya(45), Tanzania(46) as well as in northern Nigeria(47).

Most of the animals examined in the current study area had low to moderate liver fluke EPG counts and no clinical cases of fasciolosis were encountered. As reported elsewhere, most mature animals carry sublithal or subclinical fluke burdens and acquired immunity to reinfection appears to be the cause of these low burdens(4,38). However, it is apparent that these infections do contribute to production losses as reported by Preston and Castelino(27). The increased awareness of the disease, massive
increase in the use of anthelmintics and the development of other control measures appear to have made little impact on the prevalence rates of infection in the current study area.

The incidence and importance of fasciolosis, as well as the epizootiology, probably varies considerably in different parts of the country. The many types of habitat of L. natalensis will differ in importance in the various climatic and topographical combinations, and control measures which are successful for one area may not be applicable to another. For this reason, surveys should be carried out in each area where fasciolosis is a problem, and control measures planned accordingly. Abattoir returns only give an indication of infection in a whole area, but do not enable foci to be pin-pointed as there is no way of finding out from which village or other specific area an animal originated beyond elucidating the fact that it was sold at a certain market and hence probably originated in the vicinity of that market.

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The Prevalence and Intensity of Infection with Fasciola Gigantica in Cattle in Kiambu District, Kenya


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EFFECT OF REPLACING MAIZE WITH MAIZE BRAN AND CASSAVA PEELS ON BROILER PERFORMANCE AND CARCASS COMPOSITION

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EFFETS DU REMPLACEMENT DU MAIS PAR DU SON DE MAIS ET DES PELURES DE MANIOC SUR LA PERFORMANCE DES POULETS DE GRIL ET LA COMPOSITION DE LEUR CARCASSE

Résumé

Des poulets de gril Anak blancs âgés de 180 jours étaient utilisés pour déterminer les effets de remplacer le maïs par du son de maïs et des pelures de manioc sur leur performance et la composition de leur carcasse. Des niveaux croissants de son de maïs et de pelures de manioc (0/0%; 40/10%; 30/20%; 20/30% et 10/40%) remplaçant respectivement 50% de maïs dans cinq régimes alimentaires lors d’une étude qui a duré huit semaines.

Il n’y avait pas de différences significatives (P > 0,05) entre les régimes alimentaires et le gain pondéral. Le meilleur résultat de conversion alimentaire était obtenu avec le régime No. 5: remplacement du maïs par 10% de son de maïs et 40% de pelures de manioc. La consommation alimentaire avait tendance à augmenter avec l’accroissement des niveaux de fibre dans le régime. Les poulets nourris du régime No.2: 40% de son de maïs et 10% de pelures de manioc avaient le meilleur résultat de poids vidé. Le coût alimentaire a baissé lorsque le maïs dans les aliments des poulets de gril a été remplacé par le son de maïs et les pelures de manioc. Le régime No. 5 est donc recommandé à cause du coût et de l’efficacité de l’utilisation des aliments.

Summary

One hundred and eighty day old Anak white broiler chicks were used to investigate the effect of substituting maize with maize bran and cassava peels on performance and carcass composition. Graded levels of maize bran and cassava peels (0/0%, 40/10%, 30/20%, 20/30% and 10/40%) respectively replaced 50% of maize in five dietary treatments in a study which lasted for eight weeks.

There were no significant (P > 0.05) differences between diets and weight gain. The best result of feed conversion was obtained on diet 5 with 10% maize bran and 40% cassava peels substitution. Feed intake tended to increase with increasing levels of fibre in the diet. Birds fed diet 2 with 40% maize bran and 10% cassava peels had the best response of eviscerated weight. Feed cost decreased when maize in the broiler diets was replaced with maize bran and cassava peels. Diet 5 is therefore recommended in terms of cost and efficiency of feed utilization.

Introduction

The use of agro-industrial by-products in animal nutrition is gaining popularity due to the high prices of feed ingredients. Grains which constitute 50-60% by weight of balanced rations are becoming too expensive to be incorporated in animal feeds. Consequently, efforts are now geared towards inclusion of agro-industrial by-products.

Maize bran has 88% of the feeding value of maize(1) and it is rich in B-vitamins(2). It is a by-product of maize from the milling industry and in most cases, has higher protein content than the whole grain. Maize bran is a good substitute for maize in diets of laying hens(3). The use of cassava peels in poultry diets has also been reported by several authors. Sun-dried cassava peels meal can be incorporated into broiler rations up to a 15% level without any deleterious effect on broiler performance and carcass characteristics(4). Furthermore, it is economical to include cassava meal up to 50% in broiler rations(5). The objectives of the present study are to reduce feed cost using combinations of agro-industrial by-products and to determine
the effects of feeding such products on the performance of broiler chicks.

Materials and Methods

One hundred and eighty day old Anak white broiler chickens obtained from a commercial hatchery were randomly and equally allotted to five experimental diets each replicated twice (36 birds per treatment). The birds were raised for eight weeks on deep litter at the Teaching and Research Farm of the University of Agriculture, Abeokuta. Feed and water were provided ad libitum throughout the period of study. The maize bran used in this study was obtained from a milling industry while fresh cassava peels were collected from a cassava processing factory in the town. The peels were sun-dried for three days. The 50% maize component of the control diet (Diet 1) was replaced by both maize bran and sun-dried cassava peels at various levels. Diets were made to be isonitrogenous and isocaloric. Feed consumption and weight gain were recorded weekly. The composition of experimental diets is shown in Table 1. For the determination of economic analyses, the current market prices of feed ingredients were used to calculate the cost of feed per kilogram.

At the end of the experiment, four birds randomly selected from each replicate for carcass analyses were starved for 24 hours before slaughtering. Slaughtered birds were later dressed by the removal of feathers, head, and feet. The internal contents of gizzards

Table 1: Gross composition of experimental diets

<table>
<thead>
<tr>
<th>Ingredients (%)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>50.00</td>
<td>—</td>
<td>30.00</td>
<td>20.00</td>
<td>10.00</td>
</tr>
<tr>
<td>Maize bran</td>
<td>—</td>
<td>40.00</td>
<td>—</td>
<td>20.00</td>
<td>40.00</td>
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<tr>
<td>Cassava peels</td>
<td>—</td>
<td>10.00</td>
<td>—</td>
<td>30.00</td>
<td>31.00</td>
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<tr>
<td>Full fat soya</td>
<td>13.00</td>
<td>36.00</td>
<td>35.00</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Groundnut cake</td>
<td>21.00</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Rice bran</td>
<td>9.00</td>
<td>—</td>
<td>2.25</td>
<td>3.25</td>
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</tr>
<tr>
<td>Blood meal</td>
<td>—</td>
<td>0.75</td>
<td>—</td>
<td>3.25</td>
<td>—</td>
</tr>
<tr>
<td>Fish meal</td>
<td>2.25</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Palm oil</td>
<td>—</td>
<td>3.50</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
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<tr>
<td>Oyster shell</td>
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<td>1.50</td>
<td>1.50</td>
<td>1.50</td>
<td>1.50</td>
</tr>
<tr>
<td>Bone meal</td>
<td>2.50</td>
<td>2.50</td>
<td>2.50</td>
<td>2.50</td>
<td>2.50</td>
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<tr>
<td>Salt</td>
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<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
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<tr>
<td>Premix</td>
<td>0.50</td>
<td>0.50</td>
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<td>0.50</td>
<td>0.50</td>
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<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
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Calculated analysis

<table>
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<th>2</th>
<th>3</th>
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<th>5</th>
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</thead>
<tbody>
<tr>
<td>Crude protein (%)</td>
<td>22.14</td>
<td>22.07</td>
<td>22.09</td>
<td>22.13</td>
<td>22.61</td>
</tr>
<tr>
<td>Crude fibre (%)</td>
<td>4.65</td>
<td>6.94</td>
<td>8.30</td>
<td>9.58</td>
<td>10.55</td>
</tr>
<tr>
<td>ME Kcal/kg</td>
<td>2994</td>
<td>2805</td>
<td>2804</td>
<td>2834</td>
<td>2859</td>
</tr>
<tr>
<td>Cost/kg (N)</td>
<td>2.98</td>
<td>3.27</td>
<td>3.10</td>
<td>2.94</td>
<td>2.78</td>
</tr>
<tr>
<td>Cost/kg ($)</td>
<td>0.13</td>
<td>0.15</td>
<td>0.14</td>
<td>0.13</td>
<td>0.12</td>
</tr>
</tbody>
</table>

'Premix As recommended by NRC (1975)
small and large intestines were removed. The organs were later cleaned with water. Weights of liver, gizzard and intestines were recorded. The lengths of intestines were also recorded.

Diets were analysed for their proximate constituents\(^{(6)}\). All the data collected were subjected to analysis of variance using complete randomised design. The Duncan’s Multiple range test at 5% level of probability was used to access significant treatment differences\(^{(7)}\).

**Results**

The results of performance and carcass evaluation are presented in Tables 2 and 3 respectively. Although the results of weight gain were not statistically significant (P>0.05), weight gain tended to increase with increasing level of cassava peels in the diets. Diet 4 with 20% maize bran and 30% cassava peel produced the highest weight gain of 1.48 kg. Feed intake was highly influenced (P<0.05) by the graded level of maize bran and cassava peels in the diets. Feed consumption increased as the level of fibre in the diets increased. Highest feed intake value of 3.55 kg was obtained on diet 3. A value of 2.36 was obtained as the best result of efficiency of feed utilization on diet 5. Feed cost decreased with increasing level of cassava peels in the diets. Compared with the control diet, the lowest feed cost of 2.78 kg (or US$ 0.12 kg) was obtained on diet 5 containing 10% maize bran and 40% cassava peels. Throughout the period of the experiment, mortality was not recorded in any of the groups.

There were no significant differences (P>0.005) in any of the parameters studied for carcass analysis. However, birds on diet 2 with the lowest crude fibre produced the highest value of 73.28% eviscerated weight when compared with the control diet. The range of percentage eviscerated weights obtained in this study is from 65-73% of liveweight.

Abdominal fat decreased with increasing level of fibre in the diet. Lowest value of 1.24% was recorded on diet 5 with 10% crude fibre. On the other hand, the weight of the thyroid gland

<table>
<thead>
<tr>
<th>Parameters</th>
<th>1</th>
<th>2</th>
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<th>4</th>
<th>5</th>
<th>SEM</th>
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</thead>
<tbody>
<tr>
<td>Eviscerated weight (%)</td>
<td>72.80</td>
<td>73.28</td>
<td>65.82</td>
<td>69.79</td>
<td>72.04</td>
<td>8.22</td>
</tr>
<tr>
<td>Abdominal fat (%)</td>
<td>1.43</td>
<td>1.70</td>
<td>1.49</td>
<td>1.25</td>
<td>1.24</td>
<td>0.38</td>
</tr>
<tr>
<td>Thyroid gland (%)</td>
<td>0.01</td>
<td>0.01</td>
<td>0.02</td>
<td>0.02</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>Liver (%)</td>
<td>1.98</td>
<td>1.78</td>
<td>2.33</td>
<td>1.79</td>
<td>2.15</td>
<td>0.40</td>
</tr>
<tr>
<td>Gizzard (%)</td>
<td>2.45</td>
<td>2.56</td>
<td>2.66</td>
<td>2.85</td>
<td>3.29</td>
<td>0.33</td>
</tr>
<tr>
<td>Large intestine (%)</td>
<td>0.12</td>
<td>0.12</td>
<td>0.14</td>
<td>0.15</td>
<td>0.21</td>
<td>0.02</td>
</tr>
<tr>
<td>Small intestine (%)</td>
<td>2.01</td>
<td>2.04</td>
<td>2.19</td>
<td>2.66</td>
<td>2.99</td>
<td>0.36</td>
</tr>
<tr>
<td>Caeca (%)</td>
<td>0.29</td>
<td>0.30</td>
<td>0.32</td>
<td>0.36</td>
<td>0.40</td>
<td>0.05</td>
</tr>
<tr>
<td>Large intestine (cm)</td>
<td>8.14</td>
<td>8.45</td>
<td>10.13</td>
<td>11.25</td>
<td>11.43</td>
<td>1.12</td>
</tr>
<tr>
<td>Small intestine (cm)</td>
<td>148</td>
<td>152</td>
<td>160</td>
<td>171</td>
<td>184</td>
<td>6.48</td>
</tr>
<tr>
<td>Caeca (cm)</td>
<td>17.32</td>
<td>17.56</td>
<td>17.88</td>
<td>18.63</td>
<td>20.00</td>
<td>0.98</td>
</tr>
</tbody>
</table>
increased as the level of cassava peels increased in the diets. There was increase in the length and weight of intestines and caeca as the fibre level increased in the diets.

Discussion

It can be deduced from the result of the study that the combination of maize bran and cassava peels had no adverse effect on the growth rate of the birds. This was because sufficient energy was obtained for weight gain as a result of increased intake of feed. Cassava meal at 30% level in broiler finisher rations had no adverse effect on performance\(^8\).

The rise in feed intake on the fibrous diets was an attempt by the broilers to satisfy energy needed. This conforms with previous studies\(^9\). The best result of efficiency of feed utilization recorded in diet 3 could be attributed to the higher energy density of this diet when compared with the other diets containing maize bran and cassava peels. However, poor result of feed conversion efficiency for layers fed 50% maize bran with low energy density has been reported\(^10\). From this study it is clear that broiler chickens can perform very well on diets containing as much as 10% crude fibre. The decrease in feed cost is due to the total replacement of maize with maize bran and cassava peels which are well known to be cheap agro-industrial by-products in the country.

The peels can be obtained at no cost in areas with large scale cultivation of cassava.

The range of percentage eviscerated weights obtained in this study agrees with previous studies i.e. 65-75% in broilers\(^11\) and a range of 67-72% for cockerels\(^12\). The decrease in abdominal fat is associated with the level of fibre in the diets. Implications of fibrous diets on fatness of carcass have been documented\(^13\). The increase in the weight of the thyroid gland with increasing level of cassava peels in the diets as observed in this study has also been reported\(^14\). The authors confirmed that dietary cyanide tended to cause increase in thyroid weight either in the presence or absence of iodine and protein deficiencies. Similarly, the result of the increase in the weight of the gizzard with increasing level of fibre in the diet agrees with an earlier report\(^15\). Birds on fibrous diets exhibit greater mechanical grinding thus stimulating the muscular walls of gizzards.

In this study, high dietary fibre was responsible for the changes observed in gut morphology. The fibrous diets increased feed intake which finally caused the increase in the size of the gut. The increase in the length and weight of intestines and caeca with increasing fibre level observed in this study also conforms with the findings of other researchers\(^16\). The authors attributed the increase to the effect of high feed intake of the fibrous diets.

In conclusion, this study has demonstrated that up to 10% maize bran and 40% sun-dried cassava peels can both replace 50% maize in broiler diets without adverse effect on performance and carcass yield.

References


Received for publication on 8th November, 1993.
THE COMPARATIVE GROWTH PERFORMANCE AND CALF MORTALITY OF BUNAJI (WHITE FULANI) CALVES AND BOKOLOJI (SOKOTO GUDALI) X BUNAJI CROSSBRED CALVES REARED SEMI-INTENSIVELY

D.V. UZA and A.E. AKI,
Department of Animal Production, University of Agriculture, PMB 2373 Makurdi, Nigeria

COMPARAISON DE LA PERFORMANCE DE CROISSANCE ET DE LA MORTALITÉ CHEZ LES VEAUX BUNAJI (WHITE FULANI) ET LES VEAUX CROISES BOKOLOJI (SOKOTO GUDALI) X BUNAJI EN ELEVAGE SEMI-INTENSIF

Résumé


Le poids moyen à la mise bas était de 23,8 ± 1,94 kg, les veaux croisés (24,7 ± 1,98 kg) étant bien plus lourds (P < 0,05) que les veaux Bunaji (22,9 ± 1,90 kg). Les veaux croisés grandissaient beaucoup plus vite (P < 0,05) que les veaux Bunaji du vêlage à 9 mois. Les veaux mâles grandissaient beaucoup plus vite (P < 0,05) que les femelles de 30 jours à 9 mois. De 90 jours à 9 mois, les veaux mis bas pendant la saison pluvieuse grandissaient beaucoup plus vite (P < 0,05) que ceux mis bas durant la saison sèche.

Le taux de mortalité des veaux à 9 mois était en moyenne de 10,2 ± 1,1% avec plus de mortalité à l’âge de 30 jours (12,5 ± 1,5%). Le taux de mortalité était beaucoup plus élevé (P < 0,05) chez les veaux mis bas pendant la saison pluvieuse (14,5 ± 1,8%) que chez ceux mis bas durant la saison sèche (10,5 ± 1,2%).

L’intervalle des vêlages des mères était en moyenne de 630 ± 3 jours (21 mois). Les mères qui vêlaient en 1990 avaient des intervalles des vêlages beaucoup plus courts (P < 0,05) que celles qui mettaient bas en 1988. De même, les vaches qui vêlaient pendant la saison pluvieuse avaient des intervalles des vêlages beaucoup plus courts (P < 0,05) que ceux qui mettaient bas durant la saison sèche.

Il a été conclu que les veaux croisés Bokoloji x Bunaji avaient une meilleure performance que les veaux Bunaji, que les veaux mâles grandissaient plus vite que les femelles et que la saison des pluies était plus favorable à la croissance des veaux et à l’intervalle des vêlages.

Summary

The growth performance and calf mortality of Bunaji calves and Bokoloji x Bunaji crossbred calves reared semi-intensively at the University farm, Makurdi, Nigeria were compared from birth to 9 months of age during 1988 to 1990. Three calf crops were obtained during this period.

Mean birth weight was 23.8 ± 1.94 kg with crossbred calves (24.7 ± 1.98 kg) significantly (p < 0.05) heavier than Bunaji calves (22.9 ± 1.90 kg). The crossbred calves grew significantly (p < 0.05) faster than Bunaji calves from birth to 9 months of age. Male calves grew significantly (p < 0.05) faster than females from 30 days to 9 months of age. From 90 days to 9 months of age, calves born during the wet season grew significantly (p < 0.05) faster than those born during the dry season.

Mean calf mortality to 9 months was 10.2 ± 1.1% with most deaths occurring at 30 days of age (12.5 ± 1.5%). There was significantly (p < 0.05) higher calf mortality among calves born during the wet season (14.5 ± 1.8%) than those born during the dry season (10.5 ± 1.2%).

Mean calving interval of dams was 630 ± 3.0 days (21.0 months). Dams that calved in 1990 had significantly (p < 0.05) shorter calving intervals than those that calved in 1988. Similarly, those animals that calved during the wet season had significantly (p < 0.05) shorter calving intervals than those that calved during the dry season.

It was concluded that the Bokoloji x Bunaji crossbred calves performed better than the Bunaji calves. Male calves grew faster than females and wet season favoured calf growth and calving interval.
Introduction

Nigeria’s indigenous cattle population is estimated to be 13.9 million\(^1\) predominantly made up of 51.0% Bunaji (White Fulani), 14.0% Rahaji, 11.5% Bokolojo (Sokoto Gudali) and others\(^2\). These breeds grow slowly and reproduce poorly\(^3\).

While the Bunaji is widely distributed in Nigeria, the Bokolojo was stereotypically thought to occur mainly in Sokoto state located in the far northern part of the country. However, since the advent of Nigeria’s droughts of the early 1970s, the Bokolojo have migrated and are now distributed widely throughout Nigeria and neighbouring Sahelian countries. Under the transhumant husbandry widely practised in Nigeria, there must have been unplanned matings between the Bokolojo and the Bunaji zebu cattle resulting in crossbred offspring that need to be studied. While the Bunaji has been intensively studied, research reports on the Bokolojo is very scanty while nothing at all is known of the crossbred between Bokolojo and Bunaji. The few research reports available indicate that the Bokolojo had more favourable production traits than the Bunaji. In a fattening study, the Bokolojo was reported to have a daily liveweight gain of 920 g as compared to 880 g for the Bunaji\(^4\). Johnson et al.\(^5\) showed that the Bokolojo with a yield of 1,144 kg of milk over 266 days, performed better than the Bunaji (1,070 kg milk over 255 days). In Ghana, a mean yield of 1,529 litres over 252 days was obtained\(^6\). It does appear from these few reports that a comparison between the predominant cattle with Bokolojo x Bunaji crossbreds was necessary to aid decision on the desirability or otherwise of crossing the breeds.

Materials and Methods

Location

The study was carried out at the University farm in Makurdi which is situated at latitude 7.41°N and longitude 8.37°E. The rainy season begins in March and ends in October (8 months) while the dry season lasts from November to February (4 months). Average rainfall is 1377 mm while mean annual minimum and maximum temperatures are 25°C and 40°C respectively.

Animal Management

Bunaji dams aged between 3 – 3.5 years were kept in two separate holding pens and bred by Bunaji and Bokolojo sires respectively. The bulls were released into the holding pens to run with the breeding cows during the breeding season (July – September), and were removed thereafter. This ensured that the dams calved in the rainy season to guarantee adequate nutrition from pasture for the lactating cows and their calves.

All animals were managed semi-intensively i.e. the herdsman took the animals out daily from 09h to 15h for grazing on natural pasture. The animals were kraaled for the rest of the day.

During the dry season, dams and bulls were supplemented with 2 kg/head/day of maize silage. All animals were vaccinated annually against Rinderpest, Contagious Bovine Pleuropneumonia (CBPP), Blackquarter, Haemorrhagic Septicaemia and Anthrax. They were sprayed against ticks twice a month during the rainy season and once a month in the dry season. Similarly, all animals were dewormed three times a year. Individual calves were identified by ear tagging and weighed at birth and once a month up to 270 days (9 months).

At about 4 months of age, the Bunaji and crossbred calves were introduced to creep feed at the rate of 1 kg/head/day. The creep feed consisted of 20% cottonseed cake, 30% dried brewer’s grain and 50% guinea corn. Salt lick was provided free choice to all animals. The calves were weaned at 6 months (100 days).

Statistical Analysis

Data on birth weights, growth rate, calf mortality and calving intervals were analysed by Harvey’s least squares analysis of variance procedure\(^7\). The model included effects of year and season of calving as well as sex and breed of calf. Interactions between year and season were incorporated in the model. The residual mean square was used as the error term to test the
significance differences evaluated. Linear contrasts of least square means were computed to determine differences between groups.

Results

The Bokoloji x Bunaji crossbred calves were significantly (p<0.05) heavier than the Bunaji calves from birth to 270 days (9 months) while male calves were significantly (p<0.05) heavier than female calves from 30 days to 270 days (Table 1). While season of calving had no significant effect on birth weight, during subsequent growth from 90-270 days however, calves born in the wet season grew significantly (p<0.05) faster than those born in the dry season (Table 1).

The mean calf mortality to 270 days was 10.2±1.1% with most deaths (12.5±1.5%) occurring at 30 days of age. There was significantly (p<0.05) higher calf mortality in calves born during the wet season (14.5±1.85) than in those born in the dry season (10.5±1.2%) (Table 2).

Table 1: Least square means of calf liveweight (kg) from birth to 270 days (9 months)

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. of records</th>
<th>Birth</th>
<th>30</th>
<th>90</th>
<th>180</th>
<th>270</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall mean</td>
<td>126</td>
<td>23.8 ± 1.94</td>
<td>47.2 ± 0.79</td>
<td>86.0 ± 0.91</td>
<td>139.1 ± 1.10</td>
<td>182.5 ± 1.45</td>
</tr>
<tr>
<td>Year of calving</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1988</td>
<td>32</td>
<td>23.6 ± 1.76</td>
<td>46.4 ± 0.75</td>
<td>85.6 ± 0.95</td>
<td>138.3 ± 0.95</td>
<td>181.5 ± 1.30</td>
</tr>
<tr>
<td>1989</td>
<td>41</td>
<td>23.9 ± 1.99</td>
<td>48.1 ± 0.78</td>
<td>86.7 ± 0.95</td>
<td>139.1 ± 1.00</td>
<td>182.8 ± 1.39</td>
</tr>
<tr>
<td>1990</td>
<td>53</td>
<td>23.9 ± 2.07</td>
<td>47.1 ± 0.84</td>
<td>85.7 ± 0.97</td>
<td>139.9 ± 1.35</td>
<td>183.2 ± 1.66</td>
</tr>
<tr>
<td>Season of calving</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry</td>
<td>31</td>
<td>23.3 ± 1.85</td>
<td>46.3 ± 0.74</td>
<td>75.5 ± 0.85a</td>
<td>130.0 ± 0.95a</td>
<td>171.6 ± 1.35a</td>
</tr>
<tr>
<td>Wet</td>
<td>95</td>
<td>24.3 ± 2.03</td>
<td>48.1 ± 0.84</td>
<td>96.5 ± 0.97b</td>
<td>148.2 ± 1.25b</td>
<td>193.4 ± 1.55b</td>
</tr>
<tr>
<td>Sex of calf</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>68</td>
<td>24.0 ± 2.01</td>
<td>50.0 ± 0.86a</td>
<td>93.2 ± 0.95a</td>
<td>144.3 ± 1.18a</td>
<td>192.3 ± 1.50a</td>
</tr>
<tr>
<td>Female</td>
<td>58</td>
<td>23.6 ± 1.87</td>
<td>44.5 ± 0.72b</td>
<td>78.8 ± 0.87b</td>
<td>133.4 ± 1.02b</td>
<td>172.8 ± 1.40b</td>
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<tr>
<td>Breed of calf</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bunaji</td>
<td>61</td>
<td>22.9 ± 1.00a</td>
<td>44.2 ± 0.78a</td>
<td>81.0 ± 0.90a</td>
<td>131.3 ± 1.17a</td>
<td>174.0 ± 1.42a</td>
</tr>
<tr>
<td>Bokoloji x Bunaji</td>
<td>65</td>
<td>24.7 ± 1.98b</td>
<td>50.3 ± 0.80b</td>
<td>91.0 ± 0.92b</td>
<td>146.9 ± 1.03b</td>
<td>191.1 ± 1.48b</td>
</tr>
</tbody>
</table>

Main effects with different superscripts within a column are significantly different (P<0.05).
Table 2: Least square means of calf mortality rate (%) in Bunaji and Bokoloji x Bunaji crossbred calves to 270 days (9 months).

<table>
<thead>
<tr>
<th>Variable</th>
<th>30</th>
<th>90</th>
<th>180</th>
<th>270</th>
<th>Mean mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall mean</td>
<td>12.5 ± 1.5</td>
<td>9.6 ± 1.0</td>
<td>9.4 ± 0.9</td>
<td>9.3 ± 0.9</td>
<td>10.2 ± 1.1</td>
</tr>
<tr>
<td>Year of calving</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1988</td>
<td>14.3 ± 1.7</td>
<td>11.6 ± 1.4</td>
<td>10.8 ± 1.4</td>
<td>9.8 ± 1.1</td>
<td>11.5 ± 1.3</td>
</tr>
<tr>
<td>1989</td>
<td>11.9 ± 1.4</td>
<td>8.9 ± 0.9</td>
<td>9.1 ± 0.9</td>
<td>9.1 ± 0.9</td>
<td>10.3 ± 1.1</td>
</tr>
<tr>
<td>1990</td>
<td>11.3 ± 1.4</td>
<td>8.3 ± 0.7</td>
<td>8.0 ± 0.7</td>
<td>9.0 ± 0.7</td>
<td>8.8 ± 0.9</td>
</tr>
<tr>
<td>Season of calving</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry</td>
<td>10.5 ± 1.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.3 ± 0.9</td>
<td>9.0 ± 0.8</td>
<td>8.9 ± 0.8</td>
<td>9.5 ± 1.0</td>
</tr>
<tr>
<td>Wet</td>
<td>14.5 ± 1.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>9.9 ± 1.1</td>
<td>9.8 ± 1.2</td>
<td>9.7 ± 1.0</td>
<td>10.5 ± 1.2</td>
</tr>
<tr>
<td>Sex of calf</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>11.8 ± 1.4</td>
<td>9.2 ± 0.9</td>
<td>8.9 ± 0.8</td>
<td>8.9 ± 0.8</td>
<td>9.7 ± 1.0</td>
</tr>
<tr>
<td>Female</td>
<td>13.2 ± 1.6</td>
<td>10.0 ± 1.1</td>
<td>9.9 ± 1.2</td>
<td>9.7 ± 1.0</td>
<td>10.7 ± 1.2</td>
</tr>
<tr>
<td>Breed of calf</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bunaji</td>
<td>13.0 ± 1.6</td>
<td>10.1 ± 1.1</td>
<td>10.0 ± 1.1</td>
<td>9.9 ± 1.1</td>
<td>10.8 ± 1.2</td>
</tr>
<tr>
<td>Bokoloji x Bunaji</td>
<td>12.0 ± 1.4</td>
<td>9.1 ± 0.9</td>
<td>8.8 ± 0.9</td>
<td>8.7 ± 0.7</td>
<td>9.7 ± 1.0</td>
</tr>
</tbody>
</table>

Main effects with different superscripts within a column are significantly different (P<0.05).

Table 3: Least square means of calving interval (days) in Bunaji and Bokoloji x Bunaji crossbred cattle

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. of records</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall mean</td>
<td>150</td>
<td>630 ± 3.0 (21.0)</td>
</tr>
<tr>
<td>Year of calving</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1988</td>
<td>40</td>
<td>667 ± 67 (22.2)&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>1989</td>
<td>51</td>
<td>625 ± 2.5 (20.8)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>1990</td>
<td>59</td>
<td>598 ± 9.8 (19.9)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Season of calving</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry</td>
<td>37</td>
<td>685 ± 8.5 (22.8)&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Wet</td>
<td>113</td>
<td>575 ± 7.5 (19.2)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Sex of calf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>80</td>
<td>650 ± 5.0 (21.6)</td>
</tr>
<tr>
<td>Female</td>
<td>70</td>
<td>610 ± 1.0 (20.3)</td>
</tr>
<tr>
<td>Breed of calf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bunaji</td>
<td>72</td>
<td>640 ± 4.0 (21.3)</td>
</tr>
<tr>
<td>Bokoloji x Bunaji</td>
<td>78</td>
<td>620 ± 2.0 (20.7)</td>
</tr>
</tbody>
</table>

Figures in parenthesis are calving interval in months
Main effects with different superscripts within a column are significantly different (P<0.05)
Mean calving interval was 6.30 ± 3.0 days (21.0 months) with significantly (p<0.05) shorter calving intervals recorded during 1990 that 1988 and during the wet season than the dry season respectively (Table 3).

Discussion

Calf growth

The superior growth of the crossbred calves may have been due to either one or a combination of two factors, namely, the contribution from the Bokoloji bulls of the good genes controlling growth rate and or maternal effect from the Bunaji dams. The faster growth rate of the crossbreeds which revealed a wide weight differential of 17.1 kg post-weaning over the Bunaji, underscores the probable economic gains (over the predominant Bunaji cattle) that could be made in crossing and rearing the crossbreds. There were however, no significant effects of genotype and animal within genotype on the growth rate of both sets of calves in this study. These findings do not agree with those of Nuru et al(8) who in their study of Wadara, Shorthorn and Shorthorn x Wadara crossbred calves obtained a significant effect of genotype on growth performance and suggested that heterosis was responsible for the superior performance of the crosses. In the present study however, only two breeds were studied hence no valid conclusion on the effect of heterosis could be drawn. However, it will be desirable in future to study three breeds namely, Bunaji, Bokoloji and Bokoloji × Bunaji crossbred calves to assess superior growth performance of the crosses arising from heterosis. This is important since post-weaning growth rate has a high heritability and is also not much influenced by the effects of compensatory growth and could thus be selected for in order to improve weight of beef produced per animal at a specified age among Nigeria’s indigenous cattle breeds.

The findings that male calves were significantly (P<0.05) heavier than female calves from 30 days to 9 months of age by 50.8 kg is similar to the findings of Preston et al(10) and Uza(11) who reported male calves to perform better than their female counterparts. A poorer performance of females at weaning and post-weaning may probably be due to their sex hormone balance since the predominating secretion of oestrogen from the ovaries is known to have a depressing effect on growth.

Season of calving had no effect on birth weight which is in agreement with Ologun(12) and Otchere(13) but during subsequent growth from 90-270 days, calves born in the wet season were significantly (P<0.05) heavier than calves born during the dry season which agrees with the findings of Otchere(13). This showed the effect of nutrition in accelerating and decelerating growth rate during the wet and dry seasons respectively.

Calf mortality

The significantly (P<0.05) higher deaths in calves born during the wet season than those born in the dry season were mainly due to calf scours and calf pneumonia prevalent during the wet season. Even though lower calf mortality was recorded in the crossbred calves than the Bunaji, these differences were not significant. The findings in this study that sex of the calf had no significant effect (P>0.05) on calf mortality is similar to the findings of Jagun(14) and Otchere(13) in zebu cattle.

Calving interval

The improved calving interval with parity was consistent with the findings in Bunaji cattle in Nigeria by Oyedipe et al(15) who observed the first calving interval to be longer than subsequent ones. Dry season calvings were 110 days and significantly (P<0.05) longer than wet season calvings. These were similar to the findings of Otchere(13) for the Zebu breeds. This may be due to the general poor quality of the pasture during the dry season(16,17).

References


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AN ABATTOIR STUDY OF SEASONAL FLUCTUATIONS OF ADULTS AND LARVAL STAGES OF *HAEMONCHUS CONTORATUS* IN SHEEP IN ZIMBABWE

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¹University of Zimbabwe, Department of Paraclinical Veterinary Studies, Box MP 167, Mount Pleasant, Harare, Zimbabwe;

ENQUETE CONDUITE DANS UN ABATTOIR SUR LES VARIATIONS SAISONNIERES DES CHARGES DE *HAEMONCHUS CONTORATUS* ADULTES ET AU STADE LARVAIRE CHEZ LES MOUTONS AU ZIMBABWE

Résumé

Au total, 125 caillettes recueillies des moutons abattus dans un abattoir de petits ruminants (Mount Hampden, Barare) étaient examinées pour détecter la présence de *Haemonchus contortus* adultes et au stade larvaire, de mai 1996 à février 1997. D’après les résultats, les parasites adultes persistaient tout au long des trois saisons avec des différences significatives (P < 0,05) de la moyenne du nombre de vers adultes entre les saisons sèches et les saisons pluvieuses. On a observé des charges parasitaires plus élevées pendant les saisons pluvieuses que durant les saisons sèches. Les larves hypobiotiques apparaissaient au début de la saison fraîche et sèche (21,6%) et persistaient pendant la saison chaude et sèche (21,4%). Le nombre de larves hypobiotiques diminuait brusquement durant la saison chaude et pluvieuse. Il a été conclu qu’au Zimbabwe, l’hypobiose survient pendant les deux saisons sèches (fraîche et chaude) et que *H. contortus* survit chez l’hôte comme larves hypobiotiques et comme parasites adultes durant les saisons sèches défavorables.

Summary

A total of 123 abomasa recovered from sheep slaughtered at the small ruminant abattoir (Mount Hampden, Harare) were examined for the presence of larval and adult stages of *Haemonchus contortus* from May 1996 to February 1997. Results showed that adult parasites persisted throughout the 3 seasons with significant differences (P < 0.05) in mean adult worm counts between the dry seasons and wet seasons. Higher worm burdens were evident during the wet season rather than the dry seasons. Hypobiotic larvae appeared early in the cool dry season (21.6%) and persisted during the hot dry season (21.4%). In the warm wet season, the hypobiotic larvae declined abruptly. It was concluded, in Zimbabwe hypobiosis occurs during the two dry seasons (cool and hot) and that *H. contortus* survives in the host as both hypobiotic larvae and adults during the unfavourable dry seasons.

Introduction

*Haemonchus contortus* is the major gastrointestinal nematode causing economicss to the sheep industry in Zimbabwe. It is regarded as the most economically important nematode parasite of sheep in the country(1). The epidemiology of this parasite in zimbabwe has been studied by Grant(2). To date, the only report of arrested development of trichostrongylids in sheep (including *H. contortus*) in Zimbabwe has been published by Grant(2). Although the phenomenon has been extensively studied elsewhere under both experimental and field conditions(3), information on this aspect under local conditions is scarce. It is therefore essential to verify the occurrence of this phenomenon as it has important implications in the design of measures to control ovine haemonchoisis.

This study was conducted to investigate the seasonal fluctuations of adult and larval stages of *H. contortus* in the abomasa of sheep slaughtered at a small ruminant abattoir in
Zimbabwe. This information will be an aid in the development of a rational control program for sheep haemonchosis.

Materials and Methods

Weather Data

The climate of Zimbabwe is characterised by a warm wet season (November to April), a cool dry season (May to August) and later a hot dry period (September to October/November). All climatic data for the study were collected from a meteorological station (Henderson Research Station) situated 25 km North East of Harare. The data collected included mean monthly temperatures (minimum and maximum) and mean monthly rainfall.

Study material

From May 1996 to February 1997, a total of 123 abomasas from sheep collected from the small ruminant abattoir (Mount Hampden, Harare) were examined for the presence of adult and larval stages of H. contortus.

The specimens collected corresponded to 3 seasons (cool dry season, n = 40; hot dry season, n = 41 and warm wet season, n = 42). Animals from which the abomasas were collected came from surrounding farms in Harare, were from both sexes which were of mixed breeds aged between one and four years. Sheep are normally kept on farm paddocks and grazed on pasture all year round.

Parasitological techniques

Each abomasum was tied at both ends then detached from the rest of the viscera and carried to the laboratory. All specimens were examined within three hours of slaughter of the animals. Each specimen was opened along the major curvature and the contents were emptied into a plastic container. The mucosa was washed with water. The total number of adult H. contortus were recovered and enumerated. When parasites were too numerous to count, subsamples were taken and the total numbers calculated. The mucosa was scraped off with the edge of a scissors and digested in pepsin HCl mixture at 42°C for 6 hours. The digest were concentrated through a 400-mesh sieve (aperture 370 microns) under a water jet. An equal volume of formol solution (one part of 40% formaldehyde to 9 parts water solution) was added to each of the contents. These were labelled and stored for microscopic examination. Each sample was examined (a few millilitres at a time) under a dissecting microscope. All worm were removed and counted. Detection of worm was aided by the addition of concentrated iodin solution.

Adult parasites were identified to species level and the larval stages were identified according to the morphological features of arrested H. contortus.

Statistical Analysis

Data on worm counts was transformed logarithm (count + 1) to calculate the geometric mean. Analysis of variance was used to evaluate the seasonal differences in worm counts.

Results

Weather conditions recorded during the year study were similar to the average conditions recorded during a 6-year period. However, 1992 the country experienced a severe drought and maximum temperatures were higher than normal. Meteorological data and season distribution of worm counts are shown in Figu 1 and 2, respectively. Of the 123 abomasas examined, 100 (81.3%) were found harbouring adult H. contortus. The prevalence was high during the warm wet season and cool dry season (100%) and decreased during the hot dry season. The highest individual adult worm burden of 2590 was recorded during the warm wet season (February). There were no other helminth species identified in the abomasas. No significant difference (P<0.05) was found between mean worm counts during the two seasons and mean worm counts during warm wet season.
Figure 1: Mean monthly temperatures (maximum and minimum) and rainfall for Harare during the period of May 1996-February 1997

Figure 2: Seasonal changes in the larval and adult worm composition of Haemonchus contortus

The proportion of the early L4 (EL4), indicating hypobiotic larvae, was high in animals examined during the cool dry season and the hot dry season but declined to very low levels during the wet season (see Figure 2). A similar mean proportion of inhibited EL4 was present during cool dry season and hot dry season. The mean proportion of late L4 (LL4), indicating new infections, declined from 11.7% in the cool dry season to zero during the hot dry season and rose during the wet season (Table 1).

Table 1: Haemonchus contortus burden of sheep during the 3 seasons (mean±sd)

<table>
<thead>
<tr>
<th>Hameonchus contortus</th>
<th>Cool dry season</th>
<th>Hot dry season</th>
<th>Warm wet season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 40)</td>
<td>(n = 41)</td>
<td>(n = 42)</td>
</tr>
<tr>
<td>Adult parasites</td>
<td>300 ± 280</td>
<td>280 ± 160</td>
<td>2180 ± 410</td>
</tr>
<tr>
<td>% EL4</td>
<td>21.6 ± 10.5</td>
<td>21.4 ± 8.3</td>
<td>1.4 ± 0.6</td>
</tr>
<tr>
<td>% LL4</td>
<td>11.7 ± 5.1</td>
<td>0</td>
<td>10.1 ± 7.3</td>
</tr>
</tbody>
</table>
Discussion

The results from the study suggest that the phenomenon of hypobiosis in H. contortus followed a seasonal pattern, starting at the beginning of the cool dry season (May/June) with the larvae only resuming development at the beginning of the warm wet season.

Although H. contortus survive as hypobiotic larvae during the cool dry and the hot dry seasons, a large proportion of adults are able to survive during the same period. The observations are in agreement with findings by Verscruyssse\(^7\) in Senegal and El-Azazy\(^8\) in Saudi Arabia that H. contortus survives in the abomasum during the dry season as larval and adult stages, but in contrast with the findings of Kaufmann and Pfister\(^9\) and Ndao \textit{et al}.\(^10\) in The Gambia where H. contortus in N'Dama cattle survives the dry season exclusively as hypobiotic larvae. The cause of hypobiosis of H. contortus in Zimbabwe could be the effect of adverse environmental factors on the prepatritic stages during the beginning of the cool dry season. In other tropical and sub-tropical countries hypobiosis of many trichostrongyliids is associated with the onset of the dry season\(^7,9,11,12\). Appearance of a high proportion of LL4 during the warm wet season gives an indication that new infections also occur during this period.

Although this study revealed that hypobiosis of H. contortus occurs in sheep in Zimbabwe, the number of inhibited larvae was too small to be expected to play a major role in the occurrence of haemonchosis after resumption of development. Residual proportions of adult worms during the dry seasons is an important factor to be considered for the design of measures to control ovine haemonchosis. Given the low numbers of hypobiotic larvae during the dry season, it is clear that the residual adults are responsible for the successful repopulation of the environment during the next favourable season. However, a single anthelmintic treatment at the start of the dry season (May/June) should totally eliminate the adult and hypobiotic parasites as new infections do not occur during the dry seasons and treated animals are likely to remain worm free until very late in the wet season.

Acknowledgements

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References


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SHORT COMMUNICATION

PERI-PARTURIENT RISE IN FAECAL NEMATODE EGG COUNTS IN DJALLONKE X NUNGUA BLACKHEAD CROSSES IN THE FOREST ZONE OF GHANA.

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Peri-parturient rise, a phenomenon of high worm egg output in late pregnant and lambing ewes has for a long time been observed in the epidemiology of ovine gastrointestinal nematode infections and has indeed been reviewed(1). In some cases it has been attributed to endocrine changes accompanying parturition(2) as well as to environmental conditions(3). The influence of environmental and climatic factors, in particular rainfall, in dictating the pattern of worm infection has been reported(4,5).

It was therefore decided to compare the worm egg output between pregnant and non-pregnant Djallonke X Nungua Blackhead (NBH) ewes and unmated young Djallonke X NBH females grazing under tree plantation crop conditions where the prevailing microclimatic conditions may favour the continuous availability of infective larvae on pasture throughout the year.

The study was carried out at the Agricultural Research Station (A.R.S.) Kade, which lies on longitude 0.49°W and latitude 6.06°N. The area is 137.2m above sea level and the vegetation is semi-deciduous in type. The climatic data for the Station during the period of study was obtained from the records of the Meteorological Services, (A.R.S.) Kade.

The tree crop plantation consisted of oil palm, kola, rubber, citrus, cocoa and cashew among others.

Twenty pregnant sheep made up of Djallonke X Nungua Blackhead ewes aged 4-5 years were used as the test group and ten unmated young Djallonke X NBH females aged between 1-1.5 years were used as non-pregnant controls. Before the two groups were brought together, the test group were kept separately and were mated between the months of June and July 1993. All animals were faeces-sampled fortnightly from September 1993 until the end of August 1994 and worm egg counts made using the modified McMaster technique(6). Analysis of variance was carried out after log-transformation of data using the repeated measurement procedure(7).

The mean monthly temperature, minimum and maximum humidity and rainfall, of the area during the period of study are summarised in Figure 1 (a, b & c). The rainfall pattern though was normal as described before(8), the peak of the minor rains shifted slightly to October in 1993. There was no rainfall in January 1994 but a small amount of rainfall was recorded in February which was followed by the major season rains peaking in May.

Lambing occurred in November 1993 and lambs were not separated from their dams until the end of the experiment. Egg counts were largely the Strongyle type and Strongyloides papillosus eggs were also present in the faecal samples from the ewes. In both groups, the levels of egg output fell in October 1993 prior to lambing in the test group (Figure 2). However, a significantly (p<0.05) higher level of eggs were produced two weeks before the commencement of lambing in the test group compared to the non-pregnant control group.
Figure 1: The mean monthly (a) temperature, (b) minimum and maximum relative humidity and (c) rainfall of the experimental area.
The rise in egg counts peaked three weeks after lambing but fell abruptly in December 1993 only to rise again after April. In the control group there was no rise in egg output until March after the rains in February. The worm egg counts started declining from July (Figure 2) until the end of the experiment. The finding of higher worm egg counts in the test group of animals confirms the occurrence of the phenomenon of peri-parturient rise in worm egg counts. However, the fluctuating egg counts following the abrupt fall in worm egg counts after lambing in the test ewes might be the result of the prolonged lactation following lambing\(^9\). Brusdon\(^9\) has determined that the period 6-8 weeks after lambing is the time for the phenomenon to occur. In the present study, however, there was a significant (p<0.05) higher worm egg counts two weeks before parturition.

Worm egg output in sheep normally declines with age and by the time the animals are about four years they show very low egg counts\(^{10}\). Since the differences between the two groups of animals may be related to pregnancy and lactation, activities which involve hormones\(^{11}\), the significantly higher (p<0.05) worm egg counts in the test group could be attributed to these differences. In the non-pregnant controls, apart from a small rise in worm egg counts in March, the level of worm egg counts was similar throughout the experimental period.

**Figure 2:** The mean faecal worm egg counts from both pregnant ewes (test) and non-pregnant controls groups.
The continuous presence of *Strongyloides papillosus* eggs in the test ewes could be also related to these two factors of pregnancy and lactation, conditions which are normally associated with the decrease in the immune status of animals. The presence of infective larvae on the herbage throughout the year. However, the rise in egg counts in both groups in March after the rainfall in February supports the view that rainfall dictates the pattern of worm infection. The grazing regime in the plantation might even have favoured the exposure of animals to the infective larval challenge. The differences in worm egg counts between the test group and the controls support the view that, the peri-parturient rise in faecal nematode egg is independent of the seasonal variation in the pattern of faecal nematode egg output in sheep.

In conclusion the phenomenon is very important in the epidemiology of strongylate nematode infection of sheep and therefore should not be overlooked in control considerations.

**Acknowledgements**

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SHORT COMMUNICATION

CAPRINE COCCIDIOSIS IN NIGERIA: A STUDY OF THE SEASONAL CHANGES OF INFECTION IN RED SOKOTO (MARADI) GOATS.

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_Eimeria_ species occur in high prevalence in small ruminants in most parts of the humid and sub-humid zones of Nigeria\(^{(1-4)}\). The Red Sokoto (maradi) is one of the most important and widely distributed goat breed in Nigeria\(^{(5)}\). They are predominantly distributed around the semi-arid and arid regions of the Sokoto area of Northern Nigeria and in the Niger Republic. In Nigeria, these goats are owned mainly by the Fulani nomads and thus frequently involved in the nomadic system of livestock management.

Faecal samples were collected from the rectums of 960 Red Sokoto goats slaughtered at the Bodija abattoir, Ibadan between May 1991 and April 1992. The goats were originally raised in the Sokoto area of Northern Nigeria and transported by road for sale and slaughter at Ibadan. They were aged between 6 months and 6 years and were usually not grazed at Ibadan. Coccidian oocysts were counted by the modified MacMaster technique\(^{(6)}\) and identified on the criteria suggested by Christensen\(^{(7)}\), Levine\(^{(8)}\) and Soulsby\(^{(9)}\).

Oocysts of _Eimeria_ species were encountered in all the 960 (100%) faecal samples examined during the period. Five _Eimeria_ species, _E. arloingi_, _E. ninakohiyakimovae_, _E. intricata_, _E. parva_ and _E. ahsata_ were recovered from 98%, 82%, 68%, 52% and 24% of the samples respectively. Mixed infections were most common. Differences due to age could not be evaluated as most were over 6 months old.

Mean oocyst count/gramme (opg) of faeces was \(37.5 \times 10^3\) with a range of \(0.05 - 264 \times 10^3\). Significantly higher (P<0.05) oocyst counts were encountered in male goats. \(41.9 \times 10^3\) opg

than females (\(27 \times 10^3\) opg). As illustrated in Figure 1, there was a seasonal pattern in the monthly oocyst counts of the goats which corresponded with the pattern of rainfall recorded at Sokoto during the period.

The results show that goats in the Sokoto area of the Nigerian savanna have high prevalence of infection with coccidian species. Similar observations were recorded on the Jos plateau where 52 - 90% of the small ruminants harboured infection with coccidian species\(^{(2,3)}\). Differences in husbandry methods employed in the management of the animals may have been responsible for the higher prevalence recorded during this study since the Sokoto area is a much more drier environment than the Jos plateau.

![Figure 1: Mean faecal oocyst counts in relation to rainfall at Sokoto](image-url)
Although oocysts were recovered from all the goats throughout the year, oocyst output by the infected goats was significantly influenced by the rainfall pattern recorded at Sokoto during the study period. During the dry season, grazing animals are crowded in the few areas with available water and pasture resulting in a gradual accumulation of massive numbers of oocysts on pasture. This is responsible for the first and highest peak of oocyst counts recorded at the beginning of the rains in March. Although oocyst counts remain high during the rainy season, pasture contamination is widely dispersed accounting for the lower oocyst counts recorded at the peak of the rains in August than at the onset of the rains in March.

Although infection with coccidian parasites is very prevalent in goats in some parts of Nigeria, outbreaks of the clinical disease are rarely encountered in the field. This is because coccidiosis is primarily a disease of intensively managed young animals\(^9,10\). Under the range or nomadic system of management enjoyed by indigenous goats in Nigeria, apparently healthy animals may harbour varying levels of subclinical coccidian infection. Therefore, outbreaks of clinical coccidiosis occur only when such range-reared animals are brought together under intensive management especially in overcrowded and unhygienic conditions. In such outbreaks\(^11,12\), *E. arloigi* and *E. ninakohya-kimovae* were the predominant species encountered and this study confirm that they are common in Nigerian goats.

The control of coccidian infection of goats in the Sokoto area of the Nigerian savanna should be effectively achieved by coccidiostat therapy towards the end of the dry season in February and during April/May and July. This program of strategic medication prevents the acquisition of pathogenic levels of sporulated oocysts in susceptible animals while allowing them scope to develop some measure of acquired resistance. Good management and sanitation practices will complement the control of coccidiosis by this regime of strategic coccidiostat therapy.

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ELMINTHIASIS is the commonest disease of pigs in the tropics\textsuperscript{1,2}. Generally, helminth infestation of pigs is fundamentally said to be a herd problem, the acquisition of which depends largely on the availability of infective (extra-intestinal) stages of the parasites as well as the prevailing husbandry practices. A wide range of helminth infestations have been documented in pigs in other parts of the country\textsuperscript{3}. Although most of the reported helminths of pigs in Nigeria have no known public health significance, their presence in swine is associated with severe economic losses as evidenced by poor growth, reduced weight gains and visceral organ damage (especially of the liver) during post mortem examination\textsuperscript{4}. Antemortem diagnosis of helminth infestation in swine is based on faecal examination to demonstrate the developmental stages of parasites microscopically. This study was done to specifically determine the common helminths of pigs and the accompanying clinical signs in Zaria and its environs. The seasonal pattern of the distribution of the helminth parasites was also investigated.

Faecal samples were collected from a total of two hundred pigs from different farm locations in Zaria and its environs between November, 1992 and October, 1993. The samples were obtained directly from the rectum of the pigs in a polythene bag. All samples were labelled according to the approximate age and sex of the animal. Parasitological analysis of all samples collected was done within 24 hours of collection using the simple faecal smear (SFS) and the egg flotation technique (EFT) as described by Sloss and Kemp\textsuperscript{5}. Positive samples were further concentrated to identify specific parasite ova through measurements. In addition, clinical notes were compiled during physical examination of the animals prior to faecal collection. The general condition of the pig pens in terms of sanitation and the type of management system was also noted.

The incidence of gastrointestinal helminth infestation in the 200 pigs evaluated was 63\% (126/200). Over 53\% of pigs with helminth ova in faeces were under six months of age. Ascaris suum accounted for 43.4\% of all helminths detected while Oesophagostomum dentatum accounted for 20\%. Other helminth parasites detected included Hyostrongylus rubidus (17.1\%); Metastrongylus apri (10.3\%); Trichuris suis (8.6\%) and Ancylostoma species (0.6\%) (Table 1). Over 34\% of the pigs positive for helminth ova had multiple infestations. The peak of infestation was in the month of September. The egg flotation technique proved superior to the SFS in detecting helminth ova in faeces. It detected all positive cases revealed by SFS. The two techniques were however equally effective in detecting Ascaris suum ova. Less than 20\% of all pigs with helminth ova as detected by faecal analysis manifested clinical signs referable to helminthiasis which include stunted growth (8.3\%); anorexia (8.0\%); rough hair coat (2.3\%) and general loss of condition (1.3\%). Generally, the semi-intensive husbandry system was in practice and low levels of sanitation prevailed in the pig pens.
Table 1: Common Gastrointestinal Helminths in 126 pigs detected by Faecal examination in Zaria.

<table>
<thead>
<tr>
<th>Helminths</th>
<th>No. of pigs positive (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascaris suum</td>
<td>76 (43.4)</td>
</tr>
<tr>
<td>Ancylostoma species</td>
<td>1 (0.6)</td>
</tr>
<tr>
<td>Hysteroglyculos rubidus</td>
<td>30 (17.1)</td>
</tr>
<tr>
<td>Metastrongyulus apri</td>
<td>18 (10.3)</td>
</tr>
<tr>
<td>Oesophagostumum dentatum</td>
<td>35 (20.0)</td>
</tr>
<tr>
<td>Trichuris suis</td>
<td>15 (8.5)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>175 (100)</strong></td>
</tr>
</tbody>
</table>

*Multiple infestation detected in 43 pigs.

Intestinal helminth infestation as revealed in the study is a major problem to be reckoned with considering its economic significance. Like in other animal species, the incidence was significantly higher in younger pigs under six months of age than in adult pigs\(^6\). This observation could be attributed to the presence of acquired immunity in the adult pigs. The peak of infestation was between July and September which corresponds to the peak of rainfall within the study area. The wet environment characteristic of the rainy season provides for rapid development of infective helminth larvae from voided eggs under favourable climatic conditions. In addition, succulent vegetables carrying infective larvae abound in the environment and each animal is continuously subjected to ingestion of infective larvae. At the same time, all the cases of Metastrongyulus apri infestation were recorded within this quarter of the year (July-September). This observation may not be unconnected with the fact that there is abundance of earthworms (which serve as intermediate host) in the environment at this time of the year. On the other hand, the adverse climatic conditions during the dry season, to which extra-host stages of helminths are susceptible, might have exerted negative effects on the epizootiology of the infestations.

In most of the farms visited, the semi-intensive husbandry system was in practice. The pig pens had no concrete floors and low level of sanitation prevailed such that faecal material and urine from the pigs, feed remnants and water spillages from within the enclosures collected to form suitable environments for parasite development to which pigs gained access. This factor is likely to have been responsible for persistent infestations noticed all year round. The effective control of helminth parasites of pigs should therefore be directed towards improving husbandry practices currently in use, in combination with the use of potent anthelmintics of proven efficacy and of broad spectrum of activity against both larvae and adult helminths of pigs.

**Acknowledgement**

The authors hereby acknowledge the kind assistance of Mallam Sule and other staff of Helminthology Section of the Department of Veterinary Parasitology and Entomology, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria.

**References**


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SHORT COMMUNICATION

ANTHELMINTIC EFFICACY OF CLOSANTEL (FLUKIVER) AGAINST NATURALLY ACQUIRED GASTRO-INTESTINAL NEMATODES OF SHEEP AND GOATS IN CAMEROON

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The presence in sheep and goats at Mankon, Cameroon, of benzimidazole resistant trichostrongylosis was reported in 1987(1). This has necessitated the search for an alternative anthelmintic to control haemonchosis, trichostrongylosis and oesophagostomiasis, which are the major causes of economic loss in sheep and goat production due to parasitism in the high and mid altitude zone of Cameroon. Closantel is a salicylanilide antiparasitic compound(2) which has been shown to have antiparasitic effects on nematodes, trematodes and some arthropod parasites of economic importance in sheep, cattle and horses(3,4,5). Specifically it has high activity against nematodes and various haematophagous arthropods(6).

The present study was designed to investigate the efficacy of closantel (Flukiver) at dose levels of 2.5 and 5mg/kg given to naturally infected sheep and goats.

Sixty-two Cameroon Grassland Dwarf Goats (39 in flock A and 23 in flock B) and forty-nine Cameroon Grassland Dwarf Sheep (27 in flock C and 22 in flock D) were used for the study. The animals of flock A and C were treated with benzimidazoles while those of flocks B and D were animals recently purchased for the research station from villages in the North West Province of Cameroon and had never received any anthelmintic treatment.

The gastro-intestinal nematode species present were identified by larval differentiation from faecal cultures(7) and levels of infection were determined by a modified McMaster egg counting method(8). The animals were treated with a single dose of closantel at 2.5 mg/kg of body weight by intramuscular injection in May and three months later, they were given this anthelmintic at 5 mg/kg of body weight. Estimates of the number of ova of strongylids were obtained one day before treatment and on day 7 after treatment. Faecal cultures were made at similar times. Pre-and post-treatment faecal egg counts were compared using the paired Wilcoxon’s signed rank test(9).

The results presented in Table 1 reveal a significant reduction in egg counts only from the recently purchased goats (p<0.001) and sheep (p<0.01) (flocks B and D respectively) following treatment with closantel at 2.5 mg/kg. However, subsequent administration of closantel at 5mg/kg significantly reduced egg counts in all the flocks except the recently acquired sheep. The results further reveal that despite this significant reduction in worm egg counts, all the animals except one goat and one sheep after the first treatment and 2 sheep after the second treatment still harboured strongylid eggs.

Tables 2 and 3 show the effect of closantel treatment on the individual nematode species. There was a very significant reduction in the number of eggs of Haemonchus contortus in faeces seven days after treatment at both dose levels (p<0.01 in flocks A and C at 2.5 mg/kg; p<0.001 in flocks B and D at 2.5 mg/kg; p<0.001 in all the flocks at 5 mg/kg of body weight). By contrast the mean egg counts for Trichostrongylus sp and Oesophagostomum columbianum seven days after treatment did not differ significantly from the pre-treatment counts. The drug was also ineffective against Strongyloides papillosus.
Table 1: The effect of closantel at two dose levels on gastro-intestinal nematodes (strongyloid group) of naturally infected dwarf goats and sheep

<table>
<thead>
<tr>
<th>Dose level of closantel</th>
<th>Animal group of treatment</th>
<th>No. of Animals*</th>
<th>No with strongyloid post-treatment</th>
<th>Pre-treatment egg count mean +SD</th>
<th>Post-treatment egg count mean +SD</th>
<th>Efficacy (level of significance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5 mg/kg</td>
<td>Dwarf goats</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flock A</td>
<td>25</td>
<td>24</td>
<td>581±849</td>
<td>167±327</td>
<td>Not significant</td>
</tr>
<tr>
<td></td>
<td>Flock B</td>
<td>23</td>
<td>23</td>
<td>3541±2876</td>
<td>599±681</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Dwarf sheep</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flock C</td>
<td>22</td>
<td>21</td>
<td>782±974</td>
<td>344±447</td>
<td>Not significant</td>
</tr>
<tr>
<td></td>
<td>Flock D</td>
<td>20</td>
<td>20</td>
<td>2110±1705</td>
<td>576±469</td>
<td>p&lt;0.01</td>
</tr>
<tr>
<td>5 mg/kg</td>
<td>Dwarf goats</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flock A</td>
<td>39</td>
<td>39</td>
<td>1492±1580</td>
<td>386±736</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Flock B</td>
<td>22</td>
<td>22</td>
<td>1184±1073</td>
<td>434±389</td>
<td>p&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>Dwarf sheep</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flock C</td>
<td>27</td>
<td>25</td>
<td>3326±4080</td>
<td>588±684</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Flock D</td>
<td>22</td>
<td>22</td>
<td>782±813</td>
<td>650±515</td>
<td>Not significant</td>
</tr>
</tbody>
</table>

* This refers to the number of animals in each flock from which it was possible to obtain both pre and post-treatment faecal samples for egg counts.

Table 2: The effect of closantel at 2.5 mg/kg on *H. contortus*, *Trichostrongylus* sp and *O. columbianum* in naturally infected dwarf goats and sheep

<table>
<thead>
<tr>
<th>Types of animals</th>
<th>Exp'nal group</th>
<th>Parameters measured</th>
<th><em>H. contortus</em></th>
<th><em>Trichostrongylus</em> sp</th>
<th><em>O. columbianum</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dwarf goats</td>
<td>Flock A</td>
<td>Pre-treatment epg</td>
<td>384±560</td>
<td>124±181</td>
<td>74±108</td>
</tr>
<tr>
<td></td>
<td>(25 animals)</td>
<td>Post-treatment epg</td>
<td>0±0</td>
<td>129±252</td>
<td>38±75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>epg reduction-level of significant</td>
<td>p&lt;0.01</td>
<td>Not significant</td>
<td>Not significant</td>
</tr>
<tr>
<td></td>
<td>Flock B</td>
<td>Pre-treatment epg</td>
<td>2776±2255</td>
<td>341±277</td>
<td>425±345</td>
</tr>
<tr>
<td></td>
<td>(23 animals)</td>
<td>Post-treatment epg</td>
<td>17±20</td>
<td>224±266</td>
<td>352±400</td>
</tr>
<tr>
<td></td>
<td></td>
<td>epg reduction-level of significant</td>
<td>p&lt;0.001</td>
<td>Not significant</td>
<td>Not significant</td>
</tr>
<tr>
<td>Dwarf sheep</td>
<td>Flock C</td>
<td>Pre-treatment epg</td>
<td>491±611</td>
<td>84±105</td>
<td>207±258</td>
</tr>
<tr>
<td></td>
<td>(22 animals)</td>
<td>Post-treatment epg</td>
<td>0±0</td>
<td>148±192</td>
<td>197±255</td>
</tr>
<tr>
<td></td>
<td></td>
<td>epg reduction-level of significant</td>
<td>p&lt;0.01</td>
<td>Not significant</td>
<td>Not significant</td>
</tr>
<tr>
<td></td>
<td>Flock D</td>
<td>Pre-treatment epg</td>
<td>1072±866</td>
<td>536±433</td>
<td>502±406</td>
</tr>
<tr>
<td></td>
<td>(20 animals)</td>
<td>Post-treatment epg</td>
<td>0±0</td>
<td>399±325</td>
<td>177±144</td>
</tr>
<tr>
<td></td>
<td></td>
<td>epg reduction-level of significant</td>
<td>p&lt;0.001</td>
<td>Not significant</td>
<td>p&lt;0.01</td>
</tr>
</tbody>
</table>
Table 3: The effect of closantel at mg/kg on *H. contortus*, *Trichostrongylus* sp and *O. columbianum* in naturally infected dwarf goats and sheep

<table>
<thead>
<tr>
<th>Types of animals</th>
<th>Exp’l group</th>
<th>Parameters measured</th>
<th><em>H. contortus</em></th>
<th><em>Trichostrongylus</em> sp</th>
<th><em>O. columbianum</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dwarf goats</td>
<td>Flock A</td>
<td>Pre-treatment epg</td>
<td>1242±1317</td>
<td>115±122</td>
<td>135±142</td>
</tr>
<tr>
<td></td>
<td>(39 animals)</td>
<td>Post-treatment epg</td>
<td>12±22</td>
<td>100±206</td>
<td>267±508</td>
</tr>
<tr>
<td></td>
<td></td>
<td>epg reduction-level</td>
<td><em>p</em>&lt;0.001</td>
<td>Not significant</td>
<td>Not significant</td>
</tr>
<tr>
<td></td>
<td>Flock B</td>
<td>Pre-treatment epg</td>
<td>329±298</td>
<td>131±119</td>
<td>737±696</td>
</tr>
<tr>
<td></td>
<td>(22 animals)</td>
<td>Post-treatment epg</td>
<td>0±0</td>
<td>80±72</td>
<td>346±324</td>
</tr>
<tr>
<td></td>
<td></td>
<td>epg reduction-level</td>
<td><em>p</em>&lt;0.001</td>
<td>Not significant</td>
<td>Not significant</td>
</tr>
<tr>
<td>Dwarf sheep</td>
<td>Flock C</td>
<td>Pre-treatment epg</td>
<td>3093±3794</td>
<td>111±144</td>
<td>111±144</td>
</tr>
<tr>
<td></td>
<td>(22 animals)</td>
<td>Post-treatment epg</td>
<td>0±0</td>
<td>435±506</td>
<td>153±178</td>
</tr>
<tr>
<td></td>
<td></td>
<td>epg reduction-level</td>
<td><em>p</em>&lt;0.001</td>
<td>Not significant</td>
<td>Not significant</td>
</tr>
<tr>
<td></td>
<td>Flock D</td>
<td>Pre-treatment epg</td>
<td>213±222</td>
<td>316±328</td>
<td>253±263</td>
</tr>
<tr>
<td></td>
<td>(22 animals)</td>
<td>Post-treatment epg</td>
<td>10±8</td>
<td>161±128</td>
<td>479±380</td>
</tr>
<tr>
<td></td>
<td></td>
<td>epg reduction-level</td>
<td><em>p</em>&lt;0.001</td>
<td>Not significant</td>
<td><em>p</em>&lt;0.01</td>
</tr>
</tbody>
</table>

In general, overall reduction in egg counts was higher in sheep and goats that had not experienced any previous exposure to anthelmintic treatment (i.e. flocks B and D) than in those that had been regularly treated with benzimidazoles at the research station (i.e flocks A and C).

From the data in Table 1, it is clear that closantel at the dose levels used was ineffective in preventing worm egg contamination by treated sheep and goats although a significant reduction in egg counts had been achieved in most of the flocks. However, closantel demonstrated excellent anthelmintic activity against *H. contortus* in sheep and goats when administered by intramuscular injection at dose levels of either 2.5 mg/kg or 5 mg/kg of body weight. This is in agreement with earlier results reported by Janssen Pharmaceutica[6,10] in naturally and artificially infected sheep. The drug proved ineffective against *Trichostrongylus* species *O. columbianum* and *S. papillosus*. This may be explained by the fact that closantel is especially effective only against parasites that are either in close contact with circulating blood or that are haematophagous[8].

*H. contortus* is a blood sucker and thus was easily eliminated by the drug unlike the other nematode species identified here.

In view of the predominance, all year round, of *Haemonchus contortus*, *Trichostrongylus* species and *Oesophagostomum columbianum* in sheep and goats of the North West Province of Cameroon, the relative inefficacy of closantel against two of these species renders it an unsuitable alternative anthelmintic to the benzimidazoles for use in therapeutic or prophylactic treatment against nematode infections of sheep and goats in this region of Cameroon. It is, however, possible that an increase in the dose rate above 5 mg/kg may lead to significant reduction in post treatment egg output of *O. columbianum* as well because of its haematophagous habits.

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SHORT COMMUNICATION

RESISTANCE TO LEVAMISOLE AND BENZIMIDAZOLE ANTHelmINTICS BY HAEMONCHUS CONTOnTUS IN SHEEP IN CENTRAL KENYA


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Resistance of gastrointestinal nematodes to most families of broad-spectrum anthelmintics is recognised as a problem in several parts of the world[1,2]. Parasitic gastroenteritis dominated by Haemonchus contortus is one of the major constraints to sheep and goat production in Kenya[3,4]. Owing to favourable climatic conditions and because grazing management involving "clean" pastures is usually not practicable, control of nematode infections in Kenya is solely based on the frequent use of anthelmintics at short intervals[5]. Regular suppressive dosing has been shown to result in the development of resistance in sheep and goat nematodes in many countries, including Kenya[6,7]. The majority of these cases have involved resistance to the benzimidazole (BZ) group of anthelmintics[8,9], although strains exhibiting resistance to levamisole (LEV)[10,11], ivermectin (IVM) and closantel (CLO)[8] have been found as well. Also, multiple resistant strains to BZ, LEV and rafoxanide[12] and recently to the three groups of broad-spectrum anthelmintics, namely BZs, LEV and IVM[8] have been identified.

The survey was undertaken from June to August 1995 in Ndungu Njeru area of Kinangop Division, Nyandarua District in Central Province of Kenya. The district is situated at an altitude of approximately 2,750 m and the mean annual rainfall ranges from 1015 mm to 1270 mm. The rainfall pattern is bimodal with long rains in March-May and short rains in October-December. The maximum temperatures are between 22°C and 26°C and the minimum between 6°C and 10°C with little variations between seasons. Natural vegetation is composed of open woodland with natural pastures consisting mainly of Kikuyu grass, Pennisetum clandestinum.

Six privately managed properties with more than 100 animals and on which anthelmintic (BZ, and LEV) had been used intensively for the control of gastrointestinal sheep parasites were examined. Sheep on the farms surveyed consisted mainly of crosses and occasionally of pure breeds such as Corriedale, Merino and Romney Marsh. The sheep had access to permanent natural pastures, which they grazed according to the availability of herbage. The animals were allowed to graze for about 7 hrs daily, and were housed at night in wooden raised sheds, and had free access to water and salt.

On each farm, the animals selected for faecal egg count reduction (FECR) tests (those not drenched for at least 4 weeks prior to the trial) were identified by ear tags and weighed before being randomly assigned to treatment and control groups of 10-15 sheep, of both sexes and ages ranging from 6 months to 2 years. They were treated on an individual body weight basis, according to each manufacturer’s recommendend dose rates. The following anthelmintics were used: Thiabendazole (TBZ) (Thibenzole®, Merck and Co. Inc., NJ), 66.0 mg kg⁻¹ orally; albendazole (ALB) (Valbazeño®, Smithkline, Beecham, UK), 5 mg kg orally; oxfendazole (OFZ) (Systamex®, Merck and Co. Inc. NJ), 5.0 mg kg⁻¹ orally; thiophanate (TP) (Nemafax®, May and Baker), 50.0 mg kg⁻¹ levamisole (LEV) (Wormicid®, Cosmos, Nairobi, Kenya), 7.5 mg kg⁻¹ closantel (CLO) (Flukiver®, Janssen, Belgium), 5.0 mg kg⁻¹ orally; ivermectin (IVM) (Ivomec® inj., Merck and Co. Inc., NJ), 0.2 mg kg subcutaneously (s.c.).

*Corresponding author: Tel. 831340 Fax. 631007
Faecal samples were collected per rectum at the time of treatment (Day 0) and again 14 days post-treatment. Faecal egg counts (FEC) were done by the modfield McMaster technique\(^{14}\), sensitive to 100 eggs g\(^{-1}\) of faeces (epg). Bulked faecal samples from each group at Days 0 and 14 were cultured for 10 days, infective larvae extracted following, Baermann's method and identified\(^{14}\). Arithmetic mean pre-and post-treatment FEC of control and treated groups were used to calculate the percentage efficacy\(^{31}\). An efficacy of less than 95% and a 95% confidence level of less than 90% was taken as indicating the presence of anthelmintic resistant nematodes in the flocks\(^{40}\).

Controlled efficacy tests were done to confirm the presence of BZ and LEV resistance in two composite strains of \(H. contortus\) isolated from 6 and 2 farms, respectively, where BZ and LEV resistance was detected using FECR tests. The strains were maintained in experimentally infected sheep. Thirty five parasite free 6-10 months old sheep were randomly allocated to seven groups of five animals each. Animals of each group were orally infected on day 0 with 5000 infective third stage larvae (L3), of either a suspected BZ resistant strain (Group 1 to 5) or a suspected LEV resistant strain (Groups 6 and 7, respectively). They were kept in individual pens with concrete floors and fed a ration of lucerne hay and concentrate. Water and salt were provided \textit{ad libitum}. On day 28 post-infection, each group of sheep was treated as shown in Table 2. All animals were slaughtered 7 days after treatment (Day 35 post-infection) and the number of worm present in the lumen and mucosa of the abomasum recovered and counted\(^{14}\). Efficacy percentages were calculated, defined as the difference between the geometric mean worm counts in the untreated control and the treated groups expressed as a percentage of the geometric mean worm counts in the control group\(^{17}\).

The faecal egg count reductions (FECR) are shown in Table 1. The mean pre-treatment epg on different farms varied between 300-2560. A FECR of over 98% was observed with CLO and IVM on all the farms examined.

High levels of resistance to BZs were present on all the six farms examined even though the FECR by BZs and the probenimidasoles, OFZ and TP, varied between the farms. Efficacy LEV was less than 95% on two farms (NK, ON) suggesting LEV resistance.

Faecal cultures showed that \(H. contortus\) was the main parasite present on all the farm with a few \textit{Trichostrongylus} and \textit{Oesophagostomum} species. Post-treatment faecal culture had only \(H. contortus\) larvae showing that they were resistant to LEV and BZs in two and seven farms, respectively (Table 1).

The results of the two controlled slaughter trials are shown in Table 2. The percentage reduction in worm counts of lambs treated with TBZ was 50.4%, with ALB 61.5%, with OFZ 70.1% and with TP 46.3% when compared with the untreated controls. LEV reduced worm counts of sheep by 62.3% (Table 2).

The results of the present survey indicate that antihelminthic resistance (AR), and, in particular BZ resistance, is common on sheep farms in central Kenya. BZs are the most widely used anthelmintics and therefore development of resistance to these compounds is not surprising. The levels of resistance between different BZs and between farms varied considerably (Table 1). In general the higher level of resistance was to probenimidasoles OFZ and TP. The presence of resistant \(H. contortus\) on these farms was confirmed in the controlled anthelmintic efficacy tests.

Side-resistance within the group of BZs was evident in all the six farms and these findings confirmed the previous observations that if there is resistance to one BZ anthelmimtic, side resistance to other BZs occurs even if the parasites have not encountered a given compound\(^{18,22}\).

One of the practical problems is that once BZ resistance is established in a \(H. contortus\) population, it may be retained for many generations without reversion to susceptibility. BZ-resistant strains of \(H. contortus\) did not revert back to susceptibility, even when the use of BZs was deferred for 12 generations of the parasite\(^{23}\) or for 6 consecutive years\(^{24}\). In
### Table 1: Arithmetic mean faecal egg counts (epg) and percentage efficacy of benzimidazole and non-benzimidazole anthelmintics in sheep naturally infected with *Haemonchus contortus*

<table>
<thead>
<tr>
<th>Farm</th>
<th>Anthelmintic</th>
<th>Arithmetic mean epg</th>
<th>Efficacy</th>
<th>95% confidence limits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-treatment (Day 0)</td>
<td>Post-treatment (Day 14)</td>
<td>%</td>
<td>Upper %</td>
</tr>
<tr>
<td>A.T</td>
<td>Control</td>
<td>967</td>
<td>1117</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Thiabendazole</td>
<td>2318</td>
<td>1596</td>
<td>40.4</td>
</tr>
<tr>
<td></td>
<td>Albendazole</td>
<td>1520</td>
<td>625</td>
<td>64.4</td>
</tr>
<tr>
<td></td>
<td>Oxfendazole</td>
<td>1610</td>
<td>925</td>
<td>50.3</td>
</tr>
<tr>
<td></td>
<td>Thiophanate</td>
<td>2109</td>
<td>1500</td>
<td>38.4</td>
</tr>
<tr>
<td></td>
<td>Levamisole</td>
<td>1529</td>
<td>31</td>
<td>98.2</td>
</tr>
<tr>
<td></td>
<td>Closantel</td>
<td>1457</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Ivermectin</td>
<td>1465</td>
<td>7</td>
<td>99.6</td>
</tr>
<tr>
<td>B.M</td>
<td>Control</td>
<td>1500</td>
<td>1900</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Thiabendazole</td>
<td>1060</td>
<td>520</td>
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</tr>
<tr>
<td></td>
<td>Albendazole</td>
<td>1163</td>
<td>240</td>
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</tr>
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<td>Oxfendazole</td>
<td>1013</td>
<td>819</td>
<td>36.2</td>
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<td></td>
<td>Thiophanate</td>
<td>1125</td>
<td>525</td>
<td>63.2</td>
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<tr>
<td></td>
<td>Levamisole</td>
<td>733</td>
<td>33</td>
<td>96.4</td>
</tr>
<tr>
<td></td>
<td>Closantel</td>
<td>1440</td>
<td>8</td>
<td>99.6</td>
</tr>
<tr>
<td></td>
<td>Ivermectin</td>
<td>1100</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>N.K</td>
<td>Control</td>
<td>1075</td>
<td>1275</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Thiabendazole</td>
<td>650</td>
<td>250</td>
<td>67.6</td>
</tr>
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<td>Albendazole</td>
<td>900</td>
<td>225</td>
<td>78.9</td>
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<td></td>
<td>Oxfendazole</td>
<td>1125</td>
<td>625</td>
<td>53.2</td>
</tr>
<tr>
<td></td>
<td>Thiophanate</td>
<td>1050</td>
<td>272</td>
<td>78.2</td>
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<tr>
<td></td>
<td>Levamisole</td>
<td>1775</td>
<td>575</td>
<td>72.7</td>
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<td></td>
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<td>900</td>
<td>0</td>
<td>100</td>
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<td></td>
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<td>1525</td>
<td>15</td>
<td>99.2</td>
</tr>
<tr>
<td>M.K</td>
<td>Control</td>
<td>2265</td>
<td>1867</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Thiabendazole</td>
<td>1171</td>
<td>300</td>
<td>68.9</td>
</tr>
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<td></td>
<td>Albendazole</td>
<td>1125</td>
<td>225</td>
<td>75.7</td>
</tr>
<tr>
<td></td>
<td>Oxfendazole</td>
<td>1650</td>
<td>275</td>
<td>79.8</td>
</tr>
<tr>
<td></td>
<td>Thiophanate</td>
<td>893</td>
<td>304</td>
<td>58.7</td>
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<td></td>
<td>Levamisole</td>
<td>927</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Closantel</td>
<td>1500</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Ivermectin</td>
<td>1105</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>D.M</td>
<td>Control</td>
<td>300</td>
<td>418</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Thiabendazole</td>
<td>1660</td>
<td>1116</td>
<td>38.4</td>
</tr>
<tr>
<td></td>
<td>Albendazole</td>
<td>1500</td>
<td>675</td>
<td>58.7</td>
</tr>
<tr>
<td></td>
<td>Oxfendazole</td>
<td>1520</td>
<td>1000</td>
<td>39.7</td>
</tr>
<tr>
<td></td>
<td>Thiophanate</td>
<td>1120</td>
<td>541</td>
<td>55.7</td>
</tr>
<tr>
<td></td>
<td>Levamisole</td>
<td>1013</td>
<td>419</td>
<td>62.0</td>
</tr>
<tr>
<td></td>
<td>Closantel</td>
<td>1430</td>
<td>8</td>
<td>99.5</td>
</tr>
<tr>
<td></td>
<td>Ivermectin</td>
<td>1215</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>W.M</td>
<td>Control</td>
<td>2160</td>
<td>1960</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Thiabendazole</td>
<td>1800</td>
<td>585</td>
<td>64.2</td>
</tr>
<tr>
<td></td>
<td>Albendazole</td>
<td>1775</td>
<td>415</td>
<td>74.2</td>
</tr>
<tr>
<td></td>
<td>Oxfendazole</td>
<td>1400</td>
<td>440</td>
<td>65.4</td>
</tr>
<tr>
<td></td>
<td>Thiophanate</td>
<td>2560</td>
<td>1000</td>
<td>56.9</td>
</tr>
<tr>
<td></td>
<td>Levamisole</td>
<td>1780</td>
<td>41</td>
<td>97.5</td>
</tr>
<tr>
<td></td>
<td>Closantel</td>
<td>1920</td>
<td>20</td>
<td>98.9</td>
</tr>
<tr>
<td></td>
<td>Ivermectin</td>
<td>2160</td>
<td>12</td>
<td>99.4</td>
</tr>
</tbody>
</table>

FECR% = 1 - (T2 - T1) x (C1 x C2) / 100 where T is treated, C is control, 1 is pre- and 2 is post-treatment arithmetic mean of epg.
Table 2: Efficacy of benzimidazoles and levamisole in sheep (n = 5) against two field isolates of Haemonchus contortus

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Dosage</th>
<th>Mean worm count (range)</th>
<th>Efficacy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infected untreated control</td>
<td>-</td>
<td>1899 (801-2660)</td>
<td>50.4</td>
</tr>
<tr>
<td>Thiabendazole</td>
<td>66.0 mg kg⁻¹</td>
<td>941 (308-2280)</td>
<td>61.5</td>
</tr>
<tr>
<td>Albendazole</td>
<td>5.0 mg kg⁻¹</td>
<td>732 (210-1517)</td>
<td>70.1</td>
</tr>
<tr>
<td>Oxfendazole</td>
<td>5.0 mg kg⁻¹</td>
<td>568 (60-1670)</td>
<td>46.3</td>
</tr>
<tr>
<td>Thiophanate</td>
<td>5.0 mg kg⁻¹</td>
<td>1019 (811-2416)</td>
<td></td>
</tr>
<tr>
<td>Trial 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infected untreated control</td>
<td>-</td>
<td>2002 (1361-3117)</td>
<td></td>
</tr>
<tr>
<td>Levamisole</td>
<td>-</td>
<td>755 (416-1964)</td>
<td>62.3</td>
</tr>
<tr>
<td></td>
<td>7.5 mg kg⁻¹</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Anthelmintics administered orally. Efficacy was calculated on the basis of the difference in worm counts between treated and control groups.\(\text{\textsuperscript{17}}\). 

country like Kenya where prevailing climatic conditions maintain a continuous cycle of infection between the host and the pasture, several generations of H. contortus would occur within a year and, as anthelmintic treatment are frequent, selection pressure for resistance is very high.

Faecal egg count reduction tests indicated the presence of LEV resistant nematodes on two sheep farms, on which BZ resistance had also been shown. Multiple resistance was therefore suspected on these farms and it involved H. contortus.

Of the currently available anthelmintics, IVM and CLO were highly effective against BZ and LEV resistant H. contortus population. Thus, the problem of control of multiple resistant H. contortus may be temporarily overcome by their use. Moreover, the prolonged activity of CLO\(\text{\textsuperscript{26}}\) and parenteral IVM\(\text{\textsuperscript{26}}\), which could prevent the establishment of incoming larvae, could additionally reduce the rate of re-infection and pasture contamination and increase the intervals between treatments\(\text{\textsuperscript{27}}\).

In view of the high level of resistance to BZs, LEV and the danger of development of resistance to other groups of anthelmintics, rational use of these drugs is necessary to preserve the life of currently available anthelmintics. Several strategies for reducing the development and spread of anthelmintic resistant nematodes\(\text{\textsuperscript{28}}\) and for the control of resistance\(\text{\textsuperscript{29}}\) have been advocated, which can be used in different ecological situations. Other strategies of worm control, such as breeding of sheep for resistance to nematodes, merit serious consideration.

In conclusion, although the present results from six farms can not be used to generalise for the whole country or region, they clearly indicate that AR is emerging as an important and serious problem for the sheep and probably goat industry in Kenya.

Acknowledgements

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References


Received for publication on 22nd November, 1996
Faecal samples were collected per rectum at the time of treatment (Day 0) and again 14 days post-treatment. Faecal egg counts (FEC) were done by the modified McMaster technique sensitive to 100 eggs g⁻¹ of faeces (epg). Bulked faecal samples from each group at Days 0 and 14 were cultured for 10 days, infective larvae extracted following Baermann’s method and identified. Arithmetic mean pre-and post-treatment FEC of control and treated groups were used to calculate the percentage efficacy. An efficacy of less than 95% and a 95% confidence level of less than 90% was taken as indicating the presence of anthelmintic resistant nematodes in the flocks.

Controlled efficacy tests were done to confirm the presence of BZ and LEV resistance in two composite strains of *H. contortus* isolated from 6 and 2 farms, respectively, where BZ and LEV resistance was detected using FECR tests. The strains were maintained in experimentally infected sheep. Thirty five parasite free 6-10 months old sheep were randomly allocated to seven groups of five animals each. Animals of each group were orally infected on day 0 with 5000 infective third stage larvae (L₃), of either a suspected BZ resistant strain (Group 1 to 5) or a suspected LEV resistant strain (Groups 6 and 7, respectively). They were kept in individual pens with concrete floors and fed a ration of lucerne hay and concentrate. Water and salt were provided *ad libitum*. On day 28 post-infection, each group of sheep was treated as shown in Table 2. All animals were slaughtered 7 days after treatment (Day 35 post-infection) and the number of worm present in the lumen and mucosa of the abomasum recovered and counted. Efficacy percentages were calculated, defined as the difference between the geometric mean worm counts in the untreated control and the treated groups expressed as a percentage of the geometric mean worm counts in the control group.

The faecal egg count reductions (FECR) are shown in Table 1. The mean pre-treatment epg on different farms varied between 300-2560. A FECR of over 98% was observed with CLO and IVM on all the farms examined.

High levels of resistance to BZs were present on all the six farms examined even though FECR by BZs and the probenimidazoles, and TP, varied between the farms. Efficacy of LEV was less than 95% on two farms (NK, suggesting LEV resistance.

Faecal cultures showed that *H. contortus* was the main parasite present on all the farms, with a few *Trichostrongylus* and *Oesophagostomum* species. Post-treatment faecal cultures had only *H. contortus* larvae showing that they were resistant to LEV and BZs in two and farms, respectively (Table 1).

The results of the two controlled slaughter trials are shown in Table 2. The percentage reduction in worm counts of lambs treated with TBZ was 50.4%, with ALB 61.5%, with 70.1% and with TP 46.3% when compared to the untreated controls. LEV reduced worm counts of sheep by 62.3% (Table 2).

The results of the present survey indicate that anthelmintic resistance (AR), in particular BZ resistance, is common on sheep farms in central Kenya. BZs are the most widely used anthelmintics and therefore development of resistance to these compounds is surprising. The levels of resistance between different BZs and between farms vary considerably (Table 1). In general the high level of resistance was to probenimidazole OFZ and TP. The presence of resistance to *H. contortus* on these farms was confirmed in controlled anthelmintic efficacy tests.

Side-resistance within the group of BZs is evident in all the six farms and these findings confirmed the previous observations that if BZ resistance is present to one BZ anthelmintic, the resistance to other BZs occurs even if the parasites have not encountered a group of BZs.

One of the practical problems is that once a BZ resistance is established in a *H. contortus* population, it may be retained for many generations without reversion to susceptibility. BZ-resistant strains of *H. contortus* did revert back to susceptibility, even when the use of BZs was deferred for 12 generations of parasite or for 6 consecutive years.

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*F. M. Waruiru, J. W. Ngotaho, E. H. Wenda and P. O. Otieno*
SHORT COMMUNICATION

PARKIA FILICOIDES (WELW) IN NITROGEN SUPPLEMENTATION OF CASSAVA PEEL DIET TO THE GOAT

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Department of Animal Production, University of Ilorin, Ilorin, Nigeria.

The prevailing desire to provide cheaper alternative feed sources for livestock production has brought about the use of cassava peels in ruminant diets. Documentation exists on the use of the cassava peels by the goat(1). The limitations of cassava peels is clear in their low content of crude protein. Since the goat, through its rumen microbes, is adapted to the use of nitrogen in synthesizing its protein, the inclusion of a cheap source of nitrogen in a cassava diet could be advantageous. *Parkia filicoides* (Welw) is a legume(2) whose utilization in the diet of the goat demands investigation. This work reports the influence of nitrogen supplementation from *Parkia filicoides* (Welw) leaf meal on the utilization of cassava peels by the goat.

Twenty four Sokoto red weaner goats, 6 to 9 kg in weight were used in growth and digestion studies. There were 5 experimental diets and a control. The experimental diets comprised the following: cassava peels only, cassava peels in which 25, 50 and 75 percent were replaced by Parkia leaf meal, and Parkia leaf meal only. The control was a diet of 60 percent *Andropogon gayanus* plus 40 percent yellow maize and soy bean meal mixed in a 60 to 40 ratio. The goats were randomly assigned to 6 groups of 4 each and each group placed on each diet. The animals were dipped against ectoparasites, dewormed and were fed at 4 percent of their body weights for an initial 42 days for growth studies. On day 43, 2 goats were selected from each group for digestion trials. They were transferred to metabolism crates and allowed 10 days to adjust to confinement. Feed refusals, faeces and urine were quantified for 5 days. Individual live weights were taken prior to collection and immediately after. The feeds were analyzed following AOAC(3) methods. Faeces and urine were analyzed for total nitrogen by the micro-kjeldahl method. Dry matter (DM) feed intakes, nitrogen intake and retention values were subjected to statistical analyses(4) and the means tested(5).

A progressive increase in crude protein (CP) contents of the experimental diets with increasing levels of Parkia leaf meal and a concomitant reduction in the crude fibre contents are indicators of the nutrient characteristic of cassava peels and *Parkia filicoides* leaves. So in a mixture of the two plant materials, the cassava peel is a major contributor of crude fibre and the Parkia leaf meal contributes mainly the nitrogen. It was however observed (Table 1) that a 75 percent inclusion of Parkia leaf meal produced a crude fibre level comparable to the control but the supply of total nitrogen was hardly adequate to offset the protein deficiency in cassava peels.

<table>
<thead>
<tr>
<th>Diets</th>
<th>Parkia leaf meal</th>
<th>Cassava</th>
<th>Dry matter</th>
<th>Crude Protein</th>
<th>Crude fibre</th>
<th>Organic matter</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>100</td>
<td>88.58</td>
<td>4.05</td>
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<td>2</td>
<td>25</td>
<td>75</td>
<td>89.19</td>
<td>6.56</td>
<td>31.68</td>
<td>84.69</td>
</tr>
<tr>
<td>3</td>
<td>50</td>
<td>50</td>
<td>96.54</td>
<td>7.50</td>
<td>27.80</td>
<td>87.48</td>
</tr>
<tr>
<td>4</td>
<td>75</td>
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<td>95.95</td>
<td>9.38</td>
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<td>90.27</td>
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<tr>
<td>5</td>
<td>100</td>
<td>0</td>
<td>95.64</td>
<td>10.94</td>
<td>20.01</td>
<td>93.06</td>
</tr>
<tr>
<td>6</td>
<td>Control</td>
<td>94.80</td>
<td>14.69</td>
<td>23.60</td>
<td>89.90</td>
<td></td>
</tr>
</tbody>
</table>
Summaries of weight changes, feed intake and nitrogen utilization are presented in Table 2. The DMI values (in percentage of the mean body weights) were apparently (P<0.05) lower with the 100 percent cassava and 100 percent Parkia leaf meal when compared with other experimental diets. The pattern of DM intakes (DMI) could reflect the acceptabilities of the various diets to the goat. The goats kept on unsupplemented cassava peels and Parkia leaf meal only had low (P<0.05) DMI and did not gain weight. The nitrogen (N) intake increased with increasing levels of *Parkia filicoides* leaf meal.

Nitrogen intake values at 75 percent inclusion and 100 percent of Parkia leaf meal are the same due to a reduction (P<0.05) of DM intake of the Parkia leaf meal and a reflection of its acceptability to the goat. The total N-loss showed no definite pattern. Nitrogen retention increased with increasing Parkia leaf meal up to 75% level. The N-retention values were similar (P<0.05) at the 50 and 75 inclusion levels and comparable (P>0.05) with the control. However, the N-retention values, when related to the N intake indicated that nitrogen was most efficiently utilized at the 50 percent inclusion of Parkia leaf meal.

Parkia leaf meal is inadequate to offset the protein deficiency in cassava peels because the leaf contains 11 percent CP. This level of CP is 33 percent of the CP content of Leucaena leaf meal\(^m\). Hence, the leaves of *Parkia filicoides* are fair in their contents of crude protein. The

<table>
<thead>
<tr>
<th>Table 2: Summaries of weight changes, feed intakes and nitrogen utilization by the goat kept on <em>Parkia filicoides</em> (Welw) leaf meal and cassava peels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diets</td>
</tr>
<tr>
<td>(days)</td>
</tr>
<tr>
<td>Experimental period</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>-----</td>
</tr>
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<td>57</td>
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<table>
<thead>
<tr>
<th>Liveweights (kg)</th>
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<tbody>
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<td>Initial</td>
</tr>
<tr>
<td>6.32±0.45</td>
</tr>
<tr>
<td>Final</td>
</tr>
<tr>
<td>5.75±0.60</td>
</tr>
<tr>
<td>Daily gain (g)</td>
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<td>-0.10</td>
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<tr>
<td>Dry matter (DM)</td>
</tr>
<tr>
<td>1.37±1.12</td>
</tr>
<tr>
<td>intake (d/day)</td>
</tr>
<tr>
<td>227.74±30.09</td>
</tr>
<tr>
<td>DM intake</td>
</tr>
<tr>
<td>2.23*</td>
</tr>
<tr>
<td>((%) of body weight)</td>
</tr>
<tr>
<td>2.05*</td>
</tr>
<tr>
<td>2.68*</td>
</tr>
<tr>
<td>2.78*</td>
</tr>
<tr>
<td>2.36*</td>
</tr>
<tr>
<td>2.35*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nitrogen (N) metabolism</th>
</tr>
</thead>
<tbody>
<tr>
<td>N intake (g/day)</td>
</tr>
<tr>
<td>0.89±0.08</td>
</tr>
<tr>
<td>2.39±0.31</td>
</tr>
<tr>
<td>2.55±0.35</td>
</tr>
<tr>
<td>3.06±0.22</td>
</tr>
<tr>
<td>3.06±0.08</td>
</tr>
<tr>
<td>5.08±0.57</td>
</tr>
<tr>
<td>N loss (g/day)</td>
</tr>
<tr>
<td>0.81±0.03</td>
</tr>
<tr>
<td>1.84±0.08</td>
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<tr>
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<td>N retention (g/day)</td>
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<td>N retention</td>
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<td>28.64±8.4</td>
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<td>N retention ((%) of N-intake)</td>
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<td>N retention ((%) of digested N)</td>
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<td>91.1±5.73</td>
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<td>84.27±12.18</td>
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<td>58.13±3.37</td>
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<td>71.36±8.4</td>
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\(* = Standard deviation \\
 a b = Values in a row with different superscripts are statistically different (P<0.05) \)
cassava peels and *Parkia filicoides* leaf meal are not good enough as sole feeds for the goat. They would however complement each other. So diets composed of these 2 plant materials would be essentially suitable in the dry season feeding of the goat. The abundance of Parkia leaves relative to all other forages, the constant availability of cassava peels and abundance of sunshine to cure and/or dry these feeding stuffs are influencing factors. These observations with the attendant weight gain value of 50 g/day and the availability of the forage material at little or no cost would make the 50 percent inclusion of Parkia leaf meal a worth-while nitrogen supplement in a cassava peel diet in rural production and dry season feeding of the goat.

**Acknowledgement**

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**References**


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Note: All dimensions are in metric units.
CASE REPORT

INTESTINAL VOLVULUS IN A STILLBORN CALF

O. O. ALAKA and S. O. AKPAVIE

Department of Veterinary Pathology University of Ibadan, Ibadan, Nigeria.

Intestinal volvulus, which is the twisting of intestinal loops around its mesenteric axis is a sporadic condition observed in most species of domestic animals of various ages. It is one of the most important causes of intestinal obstructions in domestic animals. The condition has been reported more frequently in the horse\(^1\),\(^2\) and ruminants\(^3\) but uncommon in pigs\(^4\).

Although intestinal volvulus has been reported to occur in young ruminants\(^2\),\(^5\), it has not been reported in stillborn animals. A review of cases of intestinal obstructions showed that intestinal volvulus in the horse is more associated with verminous arteritis of the iliac artery\(^1\) while in neonatal calves, it occurs secondary to developmental anomalies of the bowel, the presence of large intestinal diverticula and the involvement of the gut in inflammatory adhesions\(^3\). In this report, we present a case of primary intestinal volvulus observed in a stillborn calf.

One of the pregnant cows in a group of twenty-five animals being intensively managed in a herd in Ibadan at term delivered a stillborn calf in the night. The calf was presented for postmortem examination the next morning to ascertain the cause of death. On observation, the carcass was found to be in good body condition and all parts were fully developed. The oral mucosa was markedly congested especially around the base of the tongue. The mucous membranes of the eyes had deteched while the thorax contained about 100ml of blood-tinged fluid. The lungs were teltcatic and no froth was observed in the linways. The liver was grossly enlarged and had focal diffuse areas of yellowish iscolouration. Part of the ileum was twisted about 180° along its mesenteric axis and was severely congested and distended (Figure 1). The mesentery in the region was also severely congested and had fibrin clots on the surface. Pockets of haematoma and areas of necrosis were also present. There were no associated congenital malformations in the alimentary tract.

\textbf{Figure 1:} The affected loop of intestine twisted along its mesenteric axis

Note the marked congestion and distension of affected segment.

Tissues obtained at post-mortem were fixed in 10% buffered formalin processed routinely for histopathology and stained with haematoxylin and eosin. At histology, the alveoli were incompletely distended, the alveolar septae widened and capillaries markedly congested. The affected part of the intestine showed coagulative necrosis with haemorrhages,
edema and severe neutrophilic infiltrations of
the mucosa and Peyer's patches while the
blood vessels in the submucosa were markedly
congested. There was also very mild fatty
degeneration in the liver.

The intestinal lesions described above are
consistent with those described by Rooney''.

This report has shown that intestinal volvulus
is one of the conditions that can be responsible
for pre-natal losses in cattle. We therefore
suggest that more work be done in this area to
understand the pathogenesis of this condition.

Acknowledgements
The authors wish to thank the technical and co-extend staff
of the Department of Veterinary Pathology, University of
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Objet
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.

Presentation 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 Interafrique des Ressources animales, P.O. Box 30786, Nairobi, Kenya.
Un article ne peut être soumis pour publication qu'après être proposé ailleurs, il fera l'objet de quelques modifications par le Comité de Redaction.

Genres d'articles publiés dans le Bulletin
- des communications originales
- des brèves communications
- analyse des articles proposée par le Rédacteur
- des éditoriaux
- le courrier des lecteurs
- analyse d'ouvrages
- informations et annonces

Format des articles
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 resumé ne doit pas excéder 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.
Le matériel et les méthodes utilisés.
Les résultats présentés brièvement.
Un débat sur l'importance de l'article.
Remerciements éventuels.

Bibliographie : les références bibliographiques doivent être numérotées dans l'ordre, telles qu'elles apparaissent dans le texte. L'identification des références dans le texte. L'identification des références dans le texte. se fera à l'aide de numéros (entre parenthèses) et non pas par les noms des auteurs.
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