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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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- Editorials.
- Letters to the Editor.
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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.

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Surname and initials of author(s), year of publication (in parentheses), the exact title (underlined), town of publication, publisher, first page number.

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Name of country, year of reference, followed by the name of the department or organisation, first page number.

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BULLETIN

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PREVALENCE AND RISK FACTORS ASSOCIATED WITH LAMENESS IN ZERO-GRAZED CATTLE IN UGANDA

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PREVALENCE ET FACTEURS DE RISQUE LIES A LA BOITERIE CHEZ LES BOVINS EN STABULATION PERMANENTE EN OUGANDA

Résumé

Une étude transversale a été menée pour déterminer la prévalence de la boiterie et les lésions du sabot chez les bovins en stabulation permanente dans les districts de Kampala et de Lira en Ouganda de septembre 2002 à avril 2003. L'analyse des facteurs de risque pour la boiterie a été faite à l'aide d'un modèle de régression logistique avec la boiterie comme variable dépendante et les attributs du sol (par ex. l'humidité, l'hygiène, la texture, l'inclinaison et les matériaux de construction) comme variables indépendantes.

Cent cinquante bovins en stabulation permanente âgés de plus de deux ans ont fait l'objet d'étude. La prévalence de la boiterie était de 37% et 18% à Kampala et à Lira respectivement. Soixante-quinze pour cent (75%) et 84% des bovins à Kampala et à Lira respectivement avaient au moins une lésion sur un orteil de leurs sabots ou plus et 98% des cas de boiterie étaient dus aux lésions du sabot.

Il y avait davantage de risque de boiterie chez les bovins établis sur les sols sales (Proportions de sabots affectés (PSA) = 2,10 ; 95% (Intervalles de confiance) IC : 1,33 - 3,34), les sols raboteux (PSA = 2 ; 95% IC : 1,20 - 3,33), les sols plats (PSA = 2,15 ; 95% IC : 1,31 - 3,52) et les sols complètement en béton (PSA = 2 ; 95% IC : 1,20 - 4,07). L'étude a montré que la boiterie est particulièrement grave chez les bovins qui ont des lésions similaires à la fourbure.

Mots-clés : Boiterie, bovins en stabulation permanente, facteurs de risque, Ouganda.

Summary

A cross-sectional study was conducted to establish the prevalence of lameness and claw lesions in zero-grazed cattle in Kampala and Lira Districts of Uganda from September 2002 to April 2003. Analysis of risk factors for lameness was undertaken using a logistic regression model with lameness as dependent variable and floor attributes (e.g. moisture, hygiene, texture, gradient and material of construction) as independent variables.

One hundred and fifty zero-grazed cattle above two years old were involved in the study. The prevalence of lameness was 37% and 18% in Kampala and Lira respectively. Seventy-five percent (75%) and 84% of cattle in Kampala and Lira, respectively, had at least a lesion on one or more of their claws and 98% of lameness cases arose from claw lesions.

There was increased risk of lameness in cattle on dirty floors (AOR = 2.10; 95% CI: 1.33-3.34), rugged floors (AOR = 2.00; 95% CI: 1.20-3.33), flat floors (AOR = 2.15; 95% CI: 1.31-3.52) and those entirely on concrete (AOR = 2.00; 95% CI: 1.20-4.07). The study showed that lameness is particularly important in cattle with laminitis-like lesions.

Keywords: Lameness; zero-grazed cattle; risk factors; Uganda

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Introduction

Dairy cattle lameness is considered a major hindrance to milk production globally\(^1\). The incidence of lameness has greatly increased in recent years due to vast changes in husbandry practices\(^2\). About 90% of lameness cases arise from digital lesions\(^1\).

Current developments in animal husbandry in the tropics target improvement in production levels through introduction of high yielding *Bos taurus* cattle and intensive management\(^3,4\). Animals are housed on concrete floors, which are often traumatic to the sole. The floors are also prone to accumulation of slurry that predisposes to sole erosion and digital or interdigital infections\(^3,4\). Unregulated feeding of carbohydrates aggravates the lameness problem because of its association with laminitis\(^5\). In England, inspection of culled dairy cows at slaughter revealed that nearly all animals were suffering or had suffered some form of foot damage\(^1\). An abattoir study in Uganda showed that 80% of slaughter cattle had at least a lesion in one or more of their digits\(^4\).

Although lameness is very significant economically, and is well recognized as a serious animal welfare problem in most parts of the world, its magnitude and associated risk factors have not been investigated in Uganda. This study was carried out to generate information on the magnitude of lameness and assess the risk factors associated with it in zero-grazed cattle in Uganda.

Materials and methods

*Selection of farms and animals*

One hundred and fifty (150) zero-grazed cows aged above 2 years were examined for claw lesions and lameness in 20 and 26 zero-grazing units in Kampala and Lira Districts respectively from September 2002 to April 2003. Zero-grazed cattle in and around Kampala City were examined for claw disorders during ambulatory clinics. In Lira, lists of zero-grazing units were obtained from the area offices of Send-A-Cow Uganda (SACU) and Heifer Project International (HPI). From these lists, units were randomly selected and visited.

*Data collection*

Each animal was observed from the cowshed and any abnormality in gait or posture was recorded and used to categorise it as lame or not lame. This was followed by proper restraint in a crush for claw examination\(^6\). Each claw was thoroughly washed with water using a scrubbing brush and examined for any lesions. Hoof tester, hoof knife and probes were used to assist in detecting lesions. Claw trimming was only done on request of the animal owners. Measurements of toe lengths were undertaken from the dorsal skin-horn junction to the apex of the claw using a pair of dividers and rule. Body condition scores (BCS), breed and age of study animals were also noted during physical examination.

Cattle with a combination of three or more of lesions such as flat sole, sole ulcer, under-run sole, double sole, prominent growth/laminitic rings, overgrown hooves and white line penetration, were categorised as having laminitis.

For each zero-grazing unit visited, the floors of the feeding and resting areas were inspected to establish the nature of materials used in their construction. The level of hygiene was assessed by observing the extent of accumulation of manure and also the degree of dampness or dryness of the floors. Floor textural forms were noted and
Table 1: Body condition scores and lameness in Kampala and Lira.

<table>
<thead>
<tr>
<th>Score</th>
<th>Kampala</th>
<th></th>
<th></th>
<th></th>
<th>Lira</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of animals (%)</td>
<td></td>
<td></td>
<td></td>
<td>No. of animals (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lame</td>
<td>Not lame</td>
<td></td>
<td></td>
<td>Lame</td>
<td>Not lame</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>4(67)*</td>
<td>2(33)</td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>14(38)</td>
<td>23(62)</td>
<td></td>
<td></td>
<td>11(26)</td>
<td>32(74)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>10(31)</td>
<td>22(69)</td>
<td></td>
<td></td>
<td>3(10)</td>
<td>28(90)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td>0</td>
<td>1(100)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>28 (37)</td>
<td>47 (63)</td>
<td></td>
<td></td>
<td>14 (18)</td>
<td>61 (82)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Majority of cattle of BCS 2 were lame

categorised as smooth, rough or rugged. A simple stick and rule method was used in the estimation of floor gradient or percentage slope. In this procedure, a one-metre piece of string with either end tied to 2 pieces of sticks at points 15 centimetres from the bottom of each stick was used to estimate the gradient. The two sticks were uprightly placed on the floor and the end of the string down the slope was adjusted till it was level with the one up the slope. The number of centimetres moved up the stick was directly read as the gradient of the floor in percentage. In addition, a questionnaire on farm characteristics and potential risk factors for lameness was administered.

Data analysis

To evaluate the prevalence of claw lesions and establish associations between parameters such as age, body condition, toe length, farm practices, claw lesions and lameness, univariable descriptive statistics on the data were obtained using the frequency procedure of SAS (Statistics Analysis Systems Institute, Cary, NC).

An animal with lesion(s) on any or all of her claws in addition to having abnormal gait and/or posture was categorised as lame. The significance of the associations was tested using the Chi-square test. A multivariable logistic regression model with lameness as dependent variable was fitted to assess the contribution of various floor attributes e.g. moisture, hygiene, texture, gradient and material of construction to the occurrence of lameness. The results are reported as adjusted odds ratios (AOR) and their confidence intervals.

Results

There was a high prevalence of lameness and claw lesions in both districts. Laminitis and laminitis-associated lesions were, however, more prevalent in Kampala than Lira District. Sixty-four percent (64%) and 78% of the lame cows in Kampala and Lira, respectively, had body condition scores of between 2 and 3 as illustrated in Table 1.
Table 2: Prevalence of claw lesions in Kampala and Lira Districts

<table>
<thead>
<tr>
<th>Condition</th>
<th>Kampala (n=75)</th>
<th>Lira (n=75)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heel erosion</td>
<td>53 (71)</td>
<td>57 (76)</td>
</tr>
<tr>
<td>Flat sole</td>
<td>27 (36*)</td>
<td>8 (11)</td>
</tr>
<tr>
<td>Double sole</td>
<td>12 (16*)</td>
<td>1 (1.3)</td>
</tr>
<tr>
<td>Growth rings</td>
<td>13 (17)</td>
<td>7 (9.3)</td>
</tr>
<tr>
<td>Septic pododermatitis</td>
<td>9 (12*)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>White line penetration</td>
<td>5 (6.7*)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Horizontal wall crack</td>
<td>1 (1.3)</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Vertical wall crack</td>
<td>0 (0)</td>
<td>4 (3)</td>
</tr>
<tr>
<td>Screw sole</td>
<td>8 (10*)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Sole ulcer</td>
<td>5 (6.7*)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Interdigital Hyperplasia</td>
<td>2 (2.7)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Overgrown claws</td>
<td>36 (48)</td>
<td>21 (28)</td>
</tr>
<tr>
<td>Under-run sole</td>
<td>11 (14.7*)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>White line separation</td>
<td>7 (9.3)</td>
<td>18 (24)</td>
</tr>
<tr>
<td>Sole discoloration</td>
<td>14 (18.7)</td>
<td>17 (23)</td>
</tr>
<tr>
<td>Foot rot</td>
<td>1 (1)</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Digital dermatitis</td>
<td>0 (0)</td>
<td>1 (1.3)</td>
</tr>
<tr>
<td>Laminitis</td>
<td>29 (39*)</td>
<td>2 (2)</td>
</tr>
<tr>
<td>Lameness</td>
<td>28 (37)</td>
<td>14 (18)</td>
</tr>
</tbody>
</table>

*Laminitis/laminitis-associated lesions at least 5 times more prevalent in Kampala than Lira

Prevalence of claw lesions and lameness

The prevalence of claw lesions is shown in Table 2. Laminitis-associated lesions like sole ulcer, septic pododermatitis, screw sole, and under-run sole, were reported in cows from Kampala only. Forty-eight percent (48%) and 28% of study animals in Kampala and Lira Districts, respectively, had at least a claw longer than 7.5 cm (overgrown). All cattle with sole ulcer, under-run sole, septic pododermatitis and white line penetration were lame. About 15% and 12% of lameness cases from Kampala and Lira, respectively, could not be attributed to digital lesions. The majority (96% in Kampala and 98% in Lira) of cattle with white line separation also had heel erosion. Heel erosion and dirty floors were significantly associated ($X^2 (0.05, 1) = 3.84 < < 31.34$, OR = 8.2).

Risk factor analysis

The distribution of zero-grazing units by risk factor to lameness is shown in Table 3. All the factors analysed were associated with lameness as illustrated by the Chi-square p-values ($X^2$, p) shown in Table 4.

Using cattle which were 2 years old as a reference, cattle which were 3-4 years old showed a 31% increase in risk of lameness
Table 3: Distribution of zero-grazing units according to risk factors of lameness amongst cattle in Kampala and Lira Districts.

<table>
<thead>
<tr>
<th>Farm practice/Risk</th>
<th>Category/level</th>
<th>No. of farms (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Kampala (n=20)</td>
</tr>
<tr>
<td>Moisture</td>
<td>Dry</td>
<td>8 (40)</td>
</tr>
<tr>
<td></td>
<td>Wet</td>
<td>12 (60)</td>
</tr>
<tr>
<td>Gradient</td>
<td>2 to 4%</td>
<td>14 (70)</td>
</tr>
<tr>
<td></td>
<td>&lt;2%</td>
<td>4 (20)</td>
</tr>
<tr>
<td></td>
<td>&gt;4%</td>
<td>2 (10)</td>
</tr>
<tr>
<td>Hygiene</td>
<td>Clean</td>
<td>11 (55)</td>
</tr>
<tr>
<td></td>
<td>Dirty</td>
<td>9 (45)</td>
</tr>
<tr>
<td>Texture</td>
<td>Smooth</td>
<td>5 (35)</td>
</tr>
<tr>
<td></td>
<td>Rough</td>
<td>10 (50)</td>
</tr>
<tr>
<td></td>
<td>Rugged</td>
<td>5 (25)</td>
</tr>
<tr>
<td>Material</td>
<td>Concrete</td>
<td>14 (70)</td>
</tr>
<tr>
<td></td>
<td>Concrete+murrum</td>
<td>6 (30)</td>
</tr>
</tbody>
</table>

Table 4. Distribution of cattle in Kampala District by risk factor and lameness.

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Category/level</th>
<th>No. of cattle (%)</th>
<th>X² p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lame</td>
<td>Not lame</td>
</tr>
<tr>
<td>Moisture</td>
<td>Dry</td>
<td>7 (25)</td>
<td>18 (40)</td>
</tr>
<tr>
<td></td>
<td>Wet</td>
<td>21 (75)</td>
<td>29 (60)</td>
</tr>
<tr>
<td>Gradient</td>
<td>2 to 4%</td>
<td>20 (71)</td>
<td>28 (61)</td>
</tr>
<tr>
<td></td>
<td>&lt;2%</td>
<td>4 (14)</td>
<td>14 (30)</td>
</tr>
<tr>
<td></td>
<td>&gt;4%</td>
<td>4 (14)</td>
<td>4 (9)</td>
</tr>
<tr>
<td>Hygiene</td>
<td>Clean</td>
<td>14 (50)</td>
<td>52 (57)</td>
</tr>
<tr>
<td></td>
<td>Dirty</td>
<td>14 (50)</td>
<td>20 (43)</td>
</tr>
<tr>
<td>Texture</td>
<td>Smooth</td>
<td>20 (71)</td>
<td>30 (65)</td>
</tr>
<tr>
<td></td>
<td>Rough</td>
<td>6 (21)</td>
<td>10 (20)</td>
</tr>
<tr>
<td></td>
<td>Rugged</td>
<td>2 (7)</td>
<td>1 (15)</td>
</tr>
<tr>
<td>Material</td>
<td>Concrete</td>
<td>28 (100)</td>
<td>42 (91)</td>
</tr>
<tr>
<td></td>
<td>Concrete+murrum</td>
<td>0</td>
<td>4 (9)</td>
</tr>
</tbody>
</table>

*Except for hygiene, all factors were significantly associated with lameness (p<0.05).
while those more than 4 years old had a 161% increase in risk of lameness. There was a two-fold increase in risk of lameness in cattle on dirty floors. Dirty and moist floors were significantly (p<0.05) associated with sole erosion and Whiteline separation.

There was 100% increase in risk of lameness in animals raised entirely on concrete floors compared to those raised on partly concrete and partly marrum floors. On the other hand, there was a 50% increase in risk of lameness in animals on very smooth floors while those on very rough/rugged floors had a 100% increase in risk. Compared to floors with a gentle slope (gradient 2-4%), the risk of lameness was two-fold for cattle on flat floors (gradient <2%) while there was 1.2-fold increase in risk of lameness for cattle on steep floors (gradient >4%). The adjusted odds ratios (AOR) for risks of lameness are shown in Table 5.

### Discussion

The prevalence of claw lesions (84%) in the current study compares closely to 97.7% reported in Costa Rica\(^7\). The most prevalent condition in the current study was sole erosion (76%) as opposed to laminitis (77%) in the Costa Rican study. This may be linked to greater usage of fermentable carbohydrates for feeding cattle in Costa Rica than Uganda. The high prevalence of
heel erosion and white line separation in Uganda on the other hand signifies dirty environments in the cowsheds. Development of heel erosion is strongly linked to poor hygiene in farm environments. Over 96% of animals with white line separation also had sole erosion. It would appear that erosion at the white line zone causes detachment of the horn wall from the sole leading to separation.

Most lame animals (78%) were of body condition score 3 or less. In a study, body condition scores of cows with digital lesions dropped by an average of 0.8 unit in 30 of 35 cows. Eighty-one percent (81%) of animals with toes longer than 7.5 cm were above 4 years of age. An earlier report revealed that toe length significantly increase with advancing age of the animal.

At prevalence rates of 37% and 18% in Kampala and Lira, respectively, the lameness problem was quite significant compared to figures from other parts of the world. In Midwestern United States, a prevalence of 17% was reported in 1990. Most digital lesions rarely lead to lameness unless complicated by laminitis.

There was increased risk of lameness on dirty compared to clean floors. Prolonged exposure to slurry leads to abrasion and erosion of the sole that may lead to lameness. Dirty environments have been particularly observed to predispose animals to heel erosion, necrobacillosis and even sole ulcers.

Cattle above 4 years of age had increased risk of lameness. The duration of exposure to foot injuries is less in young animals than old ones. Longevity increases the risk of exposure to injuries. In animals older than 2 years, the combined effects of age and management can change claw shape, angulation and size. Age particularly predisposes to claw overgrowth, which often results into lameness.

Animals on floors of gradient less than 2% and those on floors of gradients greater than 4% had higher risks of lameness. Most of the units in the current study had floors of gradients less than 4%. An elevated curb with a gentle slope promotes drainage in cowsheds and reduces on the risks of lameness. A cowshed should ideally have a slope of 4% from the rear to the front.

Cattle on floors that were entirely made of concrete had increased risks of lameness. Concrete floors have been over emphasized as likely to lead to increased incidence of lameness. Concrete or housing is generally detrimental to claw health while pasture is ideal. Animals on concrete should be provided with bedding for claw comfort. No form of bedding was observed in all the zero-grazing units studied. There was increased risk of lameness on rugged floors. Rough concrete has been faulted as likely to lead to increased number of hoof lesions and lameness. Irregular surface cause breakage of horn at the toe and increases wear and secondary haemorrhage in the sole.

It was concluded that, dirty, rugged, damp, flat and concrete floors were important factors in the causation of claw lesions and lameness. However, the high prevalence of laminitis and laminitis-associated lesions in Kampala is suggestive that nutrition is probably the most significant factor in the causation of lameness in zero-grazed cattle.

Acknowledgments

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References


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GASTROINTESTINAL WORM CONTROL IN SMALL RUMINANTS ON COMMUNAL FARMS IN THE EAST OF NAMIBIA: EVIDENCE OF EFFECTIVENESS OF THE TRADITIONAL SALVAGE APPROACH

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Faculty of Agriculture and Natural Resources, University of Namibia, Private Bag 13301, Windhoek, Namibia.

LUTTE CONTRE LE VER GASTRO-INTESTINAL CHEZ LES PETITS RUMINANTS DANS DES FERMES COMMUNALES A L’EST DE LA NAMIBIE : PREUVE DE L’EFFICACITE DE LA METHODE TRADITIONNELLE DE TRAITEMENT DES ANIMAUX APPAREMMENT FAIBLES

Résumé

On a fait une évaluation des résultats d’une campagne précédente qui avait recommandé un traitement stratégique tous les ans pour le contrôle des vers chez les petits ruminants pendant le mois de septembre dans des fermes communales des éleveurs à faibles ressources dans l’est de la Namibie. Aucun des éleveurs concernés n’a adopté la mesure recommandée pour les chèvres. Les éleveurs avaient uniquement recours au traitement des animaux apparemment faibles pendant les 12 mois qui ont précédé l’étude. La proportion de chèvres apparemment faibles et traitées variait d’une saison à l’autre, mais elle était beaucoup plus réduite chez les troupeaux plus petits (P < 0,05). Inversement, l’observation des couleurs des membranes muqueuses oculaires des animaux suspects sur la base de la méthode "FAMACHA" (dépistage du degré d’anémie selon la couleur des yeux) a permis de constater des animaux beaucoup plus anémiques chez les petits troupeaux (P < 0,05). Le dénombrement moyen d’œufs dans les fèces des chèvres anémiques était nettement plus élevé que chez les animaux apparemment en bonne santé, ce qui montre que les charges parasitaires étaient plus lourdes chez les petits troupeaux. Selon les conclusions, le traitement antiparasitaire appliqué aux animaux apparemment faibles a donné des résultats encourageants chez les chèvres.

Mots - clés : Chèvres, vers gastro-intestinaux.

Summary

An evaluation of the outcome of a previous campaign that had recommended one annual strategic treatment for worm control in small ruminants during the month of September in a resource-poor communal farming district in the east of Namibia was undertaken. None of the farmers involved was found to have adopted the recommended measure in goats. Farmers undertook only salvage treatment of stragglers throughout the 12 months period that preceded the study. The proportion of goats salvaged varied from season to season but it was significantly lower in smaller flocks (p < 0.05). Conversely, evaluation of ocular mucosae of suspect animals against the "FAMACHA ®" clinical eye-colour chart revealed significantly more anaemic animals in the smaller flocks (p < 0.05). Average faecal egg counts (FEC) in anaemic goats were significantly higher than those in animals that were apparently healthy indicating that parasitic burdens were greater in smaller flocks. The findings show that salvage anti-worm treatment applied to stragglers is positively rewarding in goats.

Key words: Goats; gastrointestinal worms.
Introduction

The best approach to gastrointestinal worm control in domestic animals remains a controversial issue. The most commonly recommended practice is the integrated approach. This includes the tactical drench-and-move system in which all animals in a flock are drenched then moved to parasite free or lightly contaminated pastures\(^1\),\(^2\). It also includes the system of strategic drenching of livestock on safe pastures when environmental conditions unfavourable for free-living forms of gastrointestinal helminthes predominate\(^3\),\(^4\). Careful management of the grazing environment, including control of stocking rates and appropriate rotational procedures, must accompany those measures. Frequent strategic and tactical anthelmintic treatments remain the main worm control alternatives recommended by veterinary practitioners in southern Africa\(^1\),\(^4\),\(^5\). However, problems have emerged with frequent strategic and tactical drenching, notably, the rapid development of resistant worm populations to major anthelmintic groups. This has resulted in the emergence of serious threats to the small ruminant industry in some major farming regions\(^6\),\(^7\),\(^8\). On the other hand, the nature of communal farming practiced by resource-poor farmers in most of Africa makes frequent strategic and tactical measures impracticable and unaffordable.

In light of the above considerations, a campaign launched in Okakarara communal farming district in the East of Namibia during 1999/2000 recommended one annual strategic anthelmintic treatment for entire small ruminant flocks during the month of September\(^9\). In the current study, a survey was carried out in November 2001 to determine the extent to which resource-poor communal farmers in Okakarara District had adhered to the recommendations made. The study also undertook FEC and physical examination of animals to determine what effects treatment undertaken by the farmers had on the worm burden in goats.

Materials and Methods

Study area

The geographical location and climate of Okakarara District have been described previously\(^6\). The district has about 15,000 inhabitants almost all of who are from the Herero ethnic group. As is the case all over

<table>
<thead>
<tr>
<th>Goat flock size</th>
<th>01-19</th>
<th>20-39</th>
<th>40-59</th>
<th>60-79</th>
<th>&gt;80</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of goat flocks</td>
<td>8</td>
<td>54</td>
<td>57</td>
<td>22</td>
<td>9</td>
<td>150</td>
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<tr>
<td>Total No. of goats</td>
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<td>1659</td>
<td>2721</td>
<td>1485</td>
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<td>No. of goats drenched (Oct. 2000 - Nov. 2001)</td>
<td>5</td>
<td>198</td>
<td>421</td>
<td>286</td>
<td>281</td>
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</tr>
<tr>
<td>% of goats drenched (Oct. 2000 - Nov. 2001)</td>
<td>3.7</td>
<td>11.9</td>
<td>15.5</td>
<td>19.3</td>
<td>29.6</td>
<td>17.14</td>
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<tr>
<td>No. of anaemic goats</td>
<td>21</td>
<td>119</td>
<td>60</td>
<td>8</td>
<td>2</td>
<td>210</td>
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<tr>
<td>% of anaemic goats</td>
<td>15.6</td>
<td>7.2</td>
<td>2.2</td>
<td>0.5</td>
<td>0.21</td>
<td>3.02</td>
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</tbody>
</table>
Table 2: Results of Tukey HSD tests

(a) Variable: Number of anaemic animals in different goat flock sizes. Differences with asterisk (*) are significant at p < 0.05.

<table>
<thead>
<tr>
<th>Herd category</th>
<th>≤ 19</th>
<th>20 - 39</th>
<th>40 - 59</th>
<th>60-79</th>
<th>≥ 80</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M=2.6250</td>
<td>M=2.2037</td>
<td>M=1.0526</td>
<td>M=0.36364</td>
<td>M=0.25000</td>
</tr>
<tr>
<td>≤ 19</td>
<td>0.867398</td>
<td></td>
<td>0.002511*</td>
<td>0.000032*</td>
<td>0.000324*</td>
</tr>
<tr>
<td>20 - 39</td>
<td>0.867398</td>
<td></td>
<td>0.000018*</td>
<td>0.000018*</td>
<td>0.114695</td>
</tr>
<tr>
<td>40 - 59</td>
<td>0.002511*</td>
<td>0.000018*</td>
<td></td>
<td>0.114695</td>
<td>0.339054</td>
</tr>
<tr>
<td>60 - 79</td>
<td>0.000032*</td>
<td>0.000017*</td>
<td>0.114695</td>
<td></td>
<td>0.999258</td>
</tr>
<tr>
<td>≥ 80</td>
<td>0.000324*</td>
<td>0.000077*</td>
<td>0.339054</td>
<td>0.999258</td>
<td></td>
</tr>
</tbody>
</table>

(b) Variable: number of treated goats in different goat flock sizes. Differences with asterisk (*) are significant at p < 0.05.

<table>
<thead>
<tr>
<th>Herd category</th>
<th>≤ 19</th>
<th>20 - 39</th>
<th>40 - 59</th>
<th>60-79</th>
<th>≥ 80</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M=0.62500</td>
<td>M=3.6667</td>
<td>M=7.3860</td>
<td>M=13.000</td>
<td>M=31.222</td>
</tr>
<tr>
<td>≤ 19</td>
<td>0.374945</td>
<td></td>
<td>0.000594*</td>
<td>0.000017*</td>
<td>0.000017*</td>
</tr>
<tr>
<td>20 - 39</td>
<td>0.374945*</td>
<td></td>
<td>0.000127*</td>
<td>0.000017*</td>
<td>0.000017*</td>
</tr>
<tr>
<td>40 - 59</td>
<td>0.000594*</td>
<td>0.000127*</td>
<td></td>
<td>0.000022*</td>
<td>0.000017*</td>
</tr>
<tr>
<td>60 - 79</td>
<td>0.000017*</td>
<td>0.000017*</td>
<td>0.000022*</td>
<td></td>
<td>0.000017*</td>
</tr>
<tr>
<td>≥ 80</td>
<td>0.000017*</td>
<td>0.000017*</td>
<td>0.000017*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

the East of Namibia, the predominant subsistence activity in Okakarara District is livestock production. Livestock figures for the district are as follows: 90,000 heads of cattle, 22,000 sheep and 51,000 goats. The extent of crop agriculture carried out in this part of Namibia is very minimal.

Survey

The survey involved 150 goat-owners scattered all over the district. The selection of farming households for participation in the study was based on their ownership of goats and readiness to cooperate. During the survey, farmers were asked if they
had subjected their entire flocks to the prescribed strategic drenching measure; and if not, they were required to indicate the number of animals they had drenched during the year, what anthelmintic remedies had been used and in which seasons drenching was undertaken.

Parasitological methods

In the study, suspect animals in goat flocks were identified and their ocular mucous membrane colour examined and judged against the "FAMACHA®" clinical eye-colour anaemia guide¹¹,¹²,¹³ designed for assessing the degree of clinical anaemia in sheep and goats. The "FAMACHA®" eye-colour chart permits animals to be grouped into 5 categories with category 1 for healthy animals, 2 for satisfactory cases, 3 for mildly anaemic, 4 for severely anaemic hence require treatment, and category 5 for terminally anaemic cases. Suspect animals were defined as animals observed by the owner to have consistently exhibited signs of general ill health over a period of time prior to the study.

About 3 grams (3 pellets) faecal samples were taken per rectum for the FEC from all anaemic animals identified as well as from two randomly selected animals among the healthy group in every flock. Faecal samples were placed in marked plastic bags, stored in cool boxes with ice and sent to the laboratory. The modified McMaster method for FEC was used for coproscopic analysis¹⁴.

Statistical analysis

The computer package Statistica version 6.0 was used to analyze the data. Tukey HSD was used to test for significant differences in the prevalence of anaemic animals and the number of animals dewormed between different goat flock sizes. GLM was used to determine whether there were significant differences in mean FEC’s between apparently healthy and anaemic animals.

Results

Strategic drenching

The study found that none of the farmers concerned had undertaken the comprehensive drenching of entire goat flocks recommended in strategic or tactical measures. Farmers attributed this occurrence to the exorbitant costs of registered anthelmintic remedies. More importantly, many farmers indicated they did not see why all animals within flocks, including those with no sign of disease, must be treated as prescribed for tactical or strategic treatment. Farmers indicated that they had undertaken only salvage treatment where only individual animals that exhibited clinical symptoms traditionally attributed to worm infection were drenched. They were of the opinion that diarrhoea, emaciation and general poor body conditions were the major symptoms resulting from gastrointestinal worm disease in affected animals. They admitted that milder forms of these conditions are not easily discernible. Farmers also indicated that symptoms attributed to gastrointestinal worm infection appeared sporadically in individual animals and were not restricted to any given season. Sick animals were treated whenever they were identified. Registered anthelmintic remedies available to the communal farmers were: Rigercol® (Levamizole hydrochloride 30 mg/ml), Panacur (Product of Jassen Pharmaceutica, South Africa) (5 % m/v Fenbendazole) and Sepronver® (Closantel 25 mg/ml). A few farmers also treated their sick animals with crude extracts of Harpagophyllum procumbens
(Devil's Claw), a local medicinal plant used to treat gastrointestinal worm disease and other health problems in both humans and animals. Results of the study are summarized in Tables 1, 2 & 3 and in Figure 1.

General goat flock statistics

Table 1 represents the distribution of goat flocks according to size and the sets of findings within the different flock sizes. The table indicates that the flocksize of most farmers (74%) ranged between 20-60 goats.

Table 1 and Figure 1 also show the statistics of animals found with clinical anaemia in all goat flocks (categories 4 & 5 of the "FAMACHA ®" eye-colour chart). It was also found that the number of anaemic animals found in every flock was inversely proportional to the number of goats that farmers had dewormed within the respective flocks (Figure 1). Although no significant differences were noted between the two smallest flock categories and between the largest flock categories (Table 2a), severely anaemic animals were significantly more numerous in smaller flocks than in larger flocks (Tukey HSD, p < 0.05). Tukey HSD test further showed high significant differences between the number of animals dewormed in smaller and larger goat flocks (p < 0.05), except for the two lowest categories of flocks where there was no significant difference (Table 2b). Table 3 shows that farmers dewormed more animals during the hot-dry season (October-December) than in any other season and that much fewer goats were de-wormed in other seasons.

Faecal Egg Counts (FEC)

Average FEC obtained from healthy goats were similar with no significant difference between large and small flocks (p > 0.05). The average FEC from healthy animals in both categories of flocks ranged between a few hundred eggs to as much as 2000 eggs per gram of faeces. Similarly, no significant difference (p > 0.05) was seen in the average FEC among severely anaemic animals from large and small flocks. However, the average FEC among all anaemic animals was high, ranging between 1400 and 8100 eggs per gram of faeces. There was a highly significant difference in FEC between apparently healthy goats and the anaemic ones (GLM, F = 592.0837, p < 0.00009).

Table 3: Statistics of animals drenched during the warm-wet season (Jan-Apr), the cold-dry season (May-Sep) and the hot-dry season (Oct-Dec) in Okakarara District in different goat flock sizes (Oct. 2000 - Nov. 2001).

<table>
<thead>
<tr>
<th>Goat flock size</th>
<th>01-19</th>
<th>20-39</th>
<th>40-59</th>
<th>60-79</th>
<th>&gt;80</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. goats drenched during Jan-Apr.</td>
<td>0</td>
<td>16</td>
<td>61</td>
<td>44</td>
<td>53</td>
</tr>
<tr>
<td>No. goats drenched during May-Sep.</td>
<td>1</td>
<td>60</td>
<td>127</td>
<td>77</td>
<td>82</td>
</tr>
<tr>
<td>No. goats drenched during Oct-Dec.</td>
<td>4</td>
<td>122</td>
<td>233</td>
<td>165</td>
<td>146</td>
</tr>
</tbody>
</table>
Figure 1: Figure showing the proportion of goats dewormed by farmers within different flock sizes from Oct. 2000 - Nov. 2001, and the apparent effect of the intervention on prevalence of clinical anaemia within the respective flocks.

Discussion

Based on the findings of this study, it would seem rational to conclude that communal farmers in the East of Namibia boycotted the programme of strategic treatment that had been recommended for their goat flocks. This boycott cannot be attributed to the high cost of registered anthelmintic remedies as claimed by the farmers since they had the choice to make use of freely available traditional remedies. Rather, it would appear that these farmers had not been convinced of the rationale behind the recommended intervention. In fact, as was observed to the resource-poor farmer, for whom every animal in the small flock is important, the main objective of worm control is to, with minimum input, restore the clinically affected animal to its previous state of apparent good health. This enables the affected animal to continue contributing to household income and nutritional requirements. Hence even if the veterinary expert recommends the strategic or tactical treatment, that must cover the entire flock including animals in apparent good health, the recommendation would not look a logical option to the resource-poor farmer but rather, a complete waste of time and scarce resources. This explains why the communal farmers resorted to the usual traditional salvage treatment for gastrointestinal worm disease in goats, where only stragglers that are unable to contain worm infection on their own are treated.

It must be remembered that the grazing environment in Namibia and other southern African countries has been shown to present high risks of gastrointestinal worm infection including infection by the haematophagous gastrointestinal parasite Haemonchus contortus. The presence of high FEC in anaemic goats, seen in this study, confirms high parasitic burdens in these animals and these could have included blood-sucking parasites responsible for the cases of anaemia observed. However, the prevalence of anaemia in goat flocks, especially larger flocks where the rate of
salvage deworming was more intense, was quite low. This suggests that salvage anti-worm treatment practiced by the communal farmers was responsible for reducing parasitic burdens hence parasitic disease in goats. Salvage treatment appears to have minimized the occurrence of disease in goat flocks even during the stressful hot-dry season when parasitized animals are more likely to develop clinical symptoms. The findings of Van Wyk, Besier and others support this assumption.

It is not clear why the owners of larger goat flocks involved in this study undertook more frequent salvage treatment among their animals than did owners of smaller flocks. This could be the consequence of local socio-cultural and environmental considerations. The farmers with large goat flocks appear to be individuals who have shifted from cattle production, traditionally the preferred pastoral activity among the Herero of eastern Namibia, to goat production because of the ever-increasing pressure on available grazing resources in this communal agricultural region. This group of farmers is likely to be more attentive to goat flocks and more prepared to purchase expensive drugs to treat animals showing even mild clinical signs (categories 2 & 3).

Other workers reported that frequent strategic and tactical anti-worm treatments were, in themselves, a most important cause of anthelmintic resistance. It has been shown that, in southern Africa, the phenomenon of anthelmintic resistance is specially pronounced on commercial farms where strict adherence to frequent strategic or tactical drenching is the general norm. Conversely, it has been pointed out that salvage anti-worm treatment slowed down the process of anthelmintic resistance on livestock farms.

A number of authors have elucidated the mechanisms that permit frequent strategic and tactical treatments to select severely for anthelmintic resistant sub-populations of gastrointestinal nematodes on livestock farms and how salvage treatment retards the occurrence of this phenomenon. On the strength of the above discussion, it is rational to conclude that treatment of only stragglers, a common practice in resource-poor communal farming regions in Africa, is not only an affordable and more practical anti-worm control measure for poor farmers but it is also a more sustainable worm control strategy on animal farms than is strict strategic or tactical treatment. The traditional salvage approach enables the resource-poor farmer to suppress clinical worm disease in stragglers, hence prolonging their life span and usefulness to the household. This approach also permits worm populations in refugia to play a useful role in livestock production by preventing rapid development of anthelmintic resistance on communal farms. The ability of resource-poor farmers to identify stragglers for salvage anthelmintic treatment can be enhanced if they are trained to use the "FAMACHA©" eye-colour chart correctly.

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References


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SERO - PREVALENCE OF TAENIA SAGINATA CYSTICERCOSIS IN CATTLE IN OYO STATE OF NIGERIA

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SEROPREVALENCE DE LA CYSTICERCOSSE DUE A TAENIA SAGINATA CHEZ LES BOVINS DANS L'ETAT DE OYO AU NIGERIA

Résumé

Une séroprévalence préliminaire de la cysticercose due à Taenia saginata a été effectuée pour déterminer la prévalence de l'infection chez les bovins destinés à l'abattage dans un abattoir dans le sud-ouest du Nigeria entre novembre et décembre 2001. Au total, 265 échantillons de sérum étaient prélévés à un bovin sur cinq à l'abattage pendant qu'on faisait l'inspection de la viande. L'antigène de parasite circulant était évalué à l'aide du titrage avec immunosorberant lié à une enzyme basé sur l'anticorps monoclonal (Technique ELISA - Ag). Trente-quatre échantillons de sérum (12,8%) étaient positifs à la Technique Elisa - Ag, tandis que l'inspection de la viande des mêmes animaux a permis de dépister des cysticercoses dans 9 carcases (3,4%). La séroprévalence avait une corrélation positive avec l'âge des animaux (r = 0,78). La présente étude a clairement indiqué que la méthode habituelle d'inspection de la viande ne détecte qu'une infime partie des carcases infectées par des cysticerces.

Summary

A preliminary sero - prevalence of Taenia saginata cysticercosis was carried out to determine the prevalence of the infection in cattle presented for slaughter in an abattoir in southwestern part of Nigeria between November and December, 2001. A total of 265 serum samples were collected from one out of every five cattle that entered the slaughter floor while meat inspection was conducted simultaneously. Circulating parasite antigen were estimated using a monoclonal antibody - based sandwich enzyme - linked immunosorbent assay (Ag - ELISA). Thirty-four (12.8%) serum samples were positive to the Ag - ELISA, while by meat inspection on the same animals cysticerci were detected in 9 (3.4%). Sero - prevalence was positively correlated to age of the animals (r = 0.78). This study clearly indicated that routine meat inspection procedure detects only a minor fraction of the carcasses infected with cysticerci.

Introduction

Taenia saginata cysticercosis is an infection of cattle caused by larvae of the common human tapeworm (Taenia saginata). It is cosmopolitan in distribution occurring in developing and industrialized countries1. Bovine cysticercosis is highly prevalent in many African countries2. In Nigeria, bovine cysticercosis is reported to

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be of low sporadic occurrence, but official meat inspection reports from various states of the federation and some point prevalence survey conducted in some regions of the country revealed that the infection is endemic. Detection of the infection is done largely through meat inspection in abattoirs and slaughter slabs in Nigeria and this on many occasions lead to passing of lightly infected carcasses for human consumption. More so, the pinkish translucent nature of viable cysts makes them to be elusive to meat inspectors. Clandestine slaughtering of food animals in many parts of the country also militate against effective meat inspection. This study therefore, employed the use of the Ag - ELISA as a sero-epidemiological diagnostic tool for bovine cysticercosis and compare the findings with the classical meat inspection procedure.

Materials and Method

Serum samples
A total of 265 blood samples were collected from trade cattle slaughtered at Bodija abattoir, Ibadan, Oyo State, Nigeria between November and December, 2001. The first out of every five group of cattle each that entered the slaughter floor at a time was chosen on every visitation. The blood samples were collected at the point of slaughter, transported to the laboratory and kept overnight at 4°C. The stored samples were then centrifuged at 2500g for 20 minutes, serum separated and stored in serum vials at -20°C until tested. Meat inspection was conducted on each of the carcasses and the animal's age, sex and breed were recorded.

Enzyme-linked immunosorbent assay for the detection of circulating antigen (Ag - ELISA)

The Ag - ELISA was performed as earlier described with the following modifications: incubation steps were reduced from 1 hour to 30 minutes (for coating) or 15 minutes (for other steps); all incubations were done on a shaking plate except for the last step (addition of substrate); streptavidin - horseradish peroxidase (Jackson Immunoresearch Lab Inc. West Grove PA, USA) diluted 1/10,000 was used as the conjugate. These modifications increased the sensitivity of the test without affecting the specificity. Eight negative and 2 positive control serum samples were run on each plate. The plates were read using an automated spectrophotometer (Titertek Multiskan EIA reader) at 490nm with a reference of 655nm. The optical density of each serum sample was compared with a sample of negative serum samples (N = 8) at a probability level of P = 0.001 to determine the results in the test. The cut-off value ranged between 0.025 and 0.062nm. The results were expressed in ratio (optical density/cut-off). The effect of age of cattle on sero - prevalence was estimated by Pearson's Product Moment Linear Correlation Coefficient (r).

Results

The results of the survey were as presented in Tables 1 and 2. Classical meat inspection detected cysticercosis in 9 (3.4%) while Ag - ELISA detected 34 (12.8%) positive cases out of 265 cattle examined. A total of 1626 cattle were
### Table 1: Prevalence of cysticercosis in Nigerian cattle: number of positive samples by meat inspection and Ag-ELISA techniques.

<table>
<thead>
<tr>
<th>Date of visit</th>
<th>No. of samples collected</th>
<th>Meat inspection: positive carcasses</th>
<th>Ag-ELISA: positive serum samples</th>
<th>ratio=(OD/cut-off)</th>
</tr>
</thead>
<tbody>
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<td>20/11/2001</td>
<td>10(57)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>21/11/2001</td>
<td>10(61)</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>22/11/2001</td>
<td>4(38)</td>
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<td>-</td>
<td>-</td>
</tr>
<tr>
<td>23/11/2001</td>
<td>15(59)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
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<td>3</td>
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</tr>
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<td>26/11/2001</td>
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<td>-</td>
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</tr>
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<td>27/11/2001</td>
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<td>-</td>
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<tr>
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<td>4</td>
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<td>1.18</td>
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<td>-</td>
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<td>-</td>
<td>3</td>
<td>8.08, 2.651, 1.41</td>
</tr>
<tr>
<td>05/12/2001</td>
<td>8(49)</td>
<td>3</td>
<td>3</td>
<td>1.03, 5.39, 4.23</td>
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<td>11(67)</td>
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<td>-</td>
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<td>08/12/2001</td>
<td>7(46)</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>10/12/2001</td>
<td>10(53)</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>11/12/2001</td>
<td>10(55)</td>
<td>-</td>
<td>1</td>
<td>6.89</td>
</tr>
<tr>
<td>12/12/2001</td>
<td>9(51)</td>
<td>-</td>
<td>2</td>
<td>1.46, 3.54</td>
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<tr>
<td>13/12/2001</td>
<td>11(65)</td>
<td>-</td>
<td>1</td>
<td>2.57</td>
</tr>
<tr>
<td>14/12/2001</td>
<td>11(67)</td>
<td>1</td>
<td>4</td>
<td>1.065, 31.6, 17.03, 1.39</td>
</tr>
<tr>
<td>15/12/2001</td>
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<td>-</td>
<td>2</td>
<td>1.9, 2.97</td>
</tr>
<tr>
<td>17/12/2001</td>
<td>9(59)</td>
<td>-</td>
<td>2</td>
<td>1.61, 1.03</td>
</tr>
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<td>18/12/2001</td>
<td>9(62)</td>
<td>-</td>
<td>1</td>
<td>4.3</td>
</tr>
<tr>
<td>19/12/2001</td>
<td>9(52)</td>
<td>-</td>
<td>2</td>
<td>8.42, 9.15</td>
</tr>
<tr>
<td>20/12/2001</td>
<td>10(65)</td>
<td>-</td>
<td>2</td>
<td>5.21, 1.15</td>
</tr>
</tbody>
</table>

**Total** 265(1626) 9(3.4%) 34(12.8%)

(*) In brackets are the numbers of cattle slaughtered per day.
slaughtered during the two months period. A ratio of 1 or more is considered as a sero-positive result. Two positive cases detected by meat inspection were not detected by Ag-ELISA (Table 1). A total of 128 (48.3%) male and 137 (51.7%) females were examined, more females were presented for slaughter at older age than males and younger cattle harboured more infection than the adults (Table 2). There was positive correlation between age and sero-prevalence of the infection in cattle examined \((r = 0.78)\) while sex and breed had no effect on the sero-prevalence.

### Discussion

The study area is well suited for this preliminary survey because it serves as a converging market for different breeds of cattle coming from diverse cattle producing states of Northern Nigeria and neighbouring countries such as Chad, Niger, Cameroon, Mali, Bourkina-Fasso and Republic of Benin. The market also serves as feeder to other cattle market in the Southwestern States (Oyo, Osun, Ondo, Ekiti and part of Edo States)\(^1\).

The total number of bovine cysticercosis detected by Ag-ELISA was four times higher than those detected by meat inspection. This is in agreement with earlier studies that indicated that antigen detection by ELISA is 2 - 10 times more sensitive than routine meat inspection\(^2\). The higher percentage of bovine cysticercosis detected by Ag-ELISA can be attributed to the technique's high sensitivity (92.3%) and specificity (98.7%) especially for cattle harbouring more than 50 live cysticerci\(^2\). The sensitivity of the test may however be reduced to 12.8% when less than 50 cysticerci are present and this may probably explain the two cases undetected by Ag-ELISA\(^2\). The implication of this is that the real prevalence might be higher than what was obtained by Ag-ELISA in this study. Recently, it was found out that the
Ag-ELISA can detect consistently a minimum of 5 live cysticerci in naturally infected cattle and 14 in artificially infested cattle, some other animals still escape detection for unknown reasons. The variation in the ratios obtained is an indication that Nigerian cattle harbour heavy and light infestations, probably due to the husbandry system. Majority of cattle herds in Nigeria are in the hands of the nomads whom by virtue of their continuous moving about in search of pasture exposes the animals to infection. There was a significant positive relationship between age of cattle and the sero-prevalence of cysticercosis. The 4 to 5 year age group were most affected (16.5%) while the least was the >5 year age group (8.2%). It has been observed that cattle develop a strong resistance to further challenges after the initial exposure, this may probably explain the least infection rate obtained for the age group >5 years. The general cyclic pattern presented in the age distribution may be as a result of the intensity of infection and subsequent development of immunity by the affected cattle.

The need for epidemiological studies on bovine cysticercosis in Nigeria therefore cannot be overemphasized especially as detailed information on the infection is rare and the animal husbandry system still exposes the herds to infection on daily basis. The Ag-ELISA in comparison to the routine meat inspection technique has proved useful as a sero-epidemiological tool.

Acknowledgement

The authors appreciate the efforts of the Laboratory staff of the Department of Veterinary Medicine, Prince Leopold Institute of Tropical Medicine, Antwerp, Belgium in analyzing the serum samples.

Reference

THE PREVALENCE OF GASTROINTESTINAL NEMATODES IN SMALL RUMINANTS IN SEMI-ARID TURKANA DISTRICT OF KENYA

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LA PREVALENCE DES NEMATODES GASTRO-INTESTINAUX CHEZ LES PETITS RUMINANTS DANS LE DISTRICT SEMI-ARIDE DE TURKANA AU KENYA

Résumé

Une étude a été menée dans le nord semi-aride du district de Turkana au Kenya afin d'évaluer la prévalence des nématodes gastro-intestinaux chez les petits ruminants. L'étude portait sur 1.106 petits ruminants (moutons et chèvres) de divers âges. Elle a été conduite entre janvier et août 2001 pendant les saisons sèche et pluvieuse.

Tous les animaux évacuaient des œufs de nématode tout au long de la période d'étude. L'évacuation était plus intense chez les jeunes par rapport aux adultes et l'infection était plus forte chez les moutons. Les dénombrements des œufs dans les fèces étaient beaucoup plus élevés pendant la saison des pluies à la fois chez les moutons et les chèvres. *Haemonchus contortus* était le principal nématode observé dans les coprocultures (chèvres 73%, moutons 62,8%) et lors des dénombrements de ver à la nécropsie. Les autres nématodes perçus comprenaient *Trichostrongylus axei*, *T. colubriformes*, *Bunostomum trigonocephalum*, *Oesophagostomum columbianum* et *Trichuris ovis*. Il s'agit du premier rapport sur le *B. trigonocephalum* chez les petits ruminants dans les zones semi-arides.

Il a été conclu que les helminthes gastro-intestinaux pourraient être un obstacle éventuel à la santé et à la production des petits ruminants dans le district de Turkana. *Haemonchus contortus* est le principal nématode qui affecte les petits ruminants dans cette région.

Summary

A study was undertaken in the semi-arid northern Turkana District of Kenya to estimate the prevalence of gastrointestinal nematodes in small ruminants. The study involved 1106 small ruminants (sheep and goats) of various ages. The study was conducted between January and August 2001 and covered both the dry and wet seasons.

All the animals were shedding nematode eggs throughout the study period. The shedding was higher in young compared to adults and the infection was heavier in sheep. The faecal egg counts were significantly higher during the wet season for both sheep and goats. *Haemonchus contortus* was the main nematode encountered in coprocultures (goats 73%, sheep 62.8%) and postmortem total worm counts. Other nematodes encountered included *Trichostrongylus axei*, *T. colubriformes*, *Bunostomum trigonocephalum*, *Oesophagostomum columbianum* and *Trichuris ovis*. This is the first report of *B. trigonocephalum* in small ruminants in the semi-arid areas.

It was concluded that gastrointestinal helminthes may be a potential constraint to the health and production of small ruminants in Turkana District. *Haemonchus contortus* are the main nematodes affecting the small ruminants in this area.

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Introduction

Sheep and goats with their small body size, high reproductive capacity and rapid growth rates, are ideally suited to production by resource-poor smallholder\(^1\). They can be integrated with the overall production system.

Small ruminants provide almost 30% of the meat consumed and about 16% of the milk produced in sub-Saharan Africa\(^2\). They tend to be found in drier areas. In the world, 58% of sheep and 65% of goats occur in the arid and semi-arid zone\(^2\). It has been estimated that over 80% of the 20 million sheep and goats in Kenya are found in the arid and semi-arid areas. They are reported to be the choice livestock enterprise in these areas. Their small body size requiring small feed intakes and their feeding habits enable them to access green shoots from shrubs. Due to their relatively rapid breeding cycles and short time to reach slaughter weight, they make better use of seasonally varied herbage production. They provide an important source of dietary protein in form of meat and milk\(^3\). These small ruminants account for 30% of the red meat produced in Kenya. They are also considered a means of social economic status as well as providing employment. They also play a major role in human survival during droughts and famines. However, the farmers have to contend with husbandry problems such as bacterial, viral and parasitic diseases. Gastrointestinal parasitism is one of the most prevalent problems in the arid and semi-arid areas and its chronic nature steadily eats away the farmers’ profits\(^3,4\). They impose a severe economic constraint on sheep and goats production worldwide. Losses occur due to sub-clinical parasitism and direct cost in managing infection\(^5\).

This study investigated the prevalence of gastrointestinal helminthes infection in sheep and goats in the semi-arid Turkana District of Kenya.

Materials and Methods

Study area

The study was carried out in Lopinding, Lokangae, Aposta and Natamokaron divisions of northern Turkana between January and August 2001. The district lies at an altitude of between 600 - 900m above sea level and has a mean annual rainfall is between 300 - 400mm which is unpredictable and unreliable. The area has sparse vegetation of mainly thorn bushes. Relatively green patches are found around several watering points.

Study animals

Sheep and goats of varying ages were randomly recruited for the study after the owners consented. They were grouped into either young (those less than 12 months) or mature (over 12 months) depending on the history from the owners and the presence of permanent incisor teeth. A total of 1106 animals were sampled comprising of 546 goats and 560 sheep.

Sampling and Analysis

Rectal faecal samples were taken from the sheep and goats during the wet and dry seasons. The egg per gram (EPG) of faeces was determined by the modified McMaster technique with a lower limit of detection of 100 EPG\(^6,7\). Grouped pooled coprocultures were made and the resultant larvae counted and identified according to published guidelines\(^6\). Postmor-
tem total worm counts and differentiation were done in 22 goats slaughtered in two slaughter slabs in the study area according to the published guidelines.

**Statistical analysis**

The faecal egg count data were logarithmically transformed and used for analysis of variance according to the expression $Y = \log_{10}(X + 50)$ to normalize their distribution. Log-transformed faecal egg count data were analyzed using non-repeated measures of variance (ANOVA) in the General Linear Model (GLM) procedure in SAS. Comparisons were made between species (sheep and goats), seasons (dry and rainy) and age (young and mature) using non-repeated measures ANOVA. The total worm counts from the slaughtered animals were log-transformed and their relationship with EPG determined using correlation analysis.

**Results**

**Faecal egg counts**

The arithmetic mean strongyle egg counts for the sheep and goats are shown in Table 1. Sheep were significantly heavily infected than goats during both seasons ($P<0.001$).

The young animals were shedding more nematode eggs than the mature animals ($P<0.001$). Young goats had a mean epg of 977 compared to that of the mature goats which was 355. Young sheep had a mean epg of 1549 while the mature sheep had a mean of 576. The epg levels were higher during the rainy season for both sheep and goats ($P<0.001$). The animals were shedding more strongyle nematode eggs in faeces during the wet season compared to the dry season ($P<0.0001$).

Comparing sheep and goats, the sheep were shedding more strongyle nematode eggs compared to goats throughout the two seasons (dry season mean epg for goats = 269 and sheep 437, Rainy season mean epg for goats = 562 and sheep = 1000). This was statistically significant ($P<0.0001$, Table 1).

Infected third stage larvae of *H. contortus*, *Trichostrongylus* spp and *Oesophagostomum* spp were recovered from coprocultures. *H. contortus* larvae were the most predominant species recovered. They comprised 73% of infective larvae in goat coprocultures and 62.8% in sheep coprocultures. Other species were *Trichostrongylus* spp (25% in sheep and 20.7% in goats), *Oesophagostomum* spp (9.8% in sheep and 55.7% in goats) and *Bunostomum* spp (2.4% in sheep and 0.6% in goats). There was no significant difference in the species of larvae recovered from the goats and the sheep coprocultures ($P>0.05$).

**Post-mortem worm counts**

Post-mortem total worm counts were done for goats slaughtered in two local slaughter slabs. Twenty-two gastrointestinal tracts were obtained from these slabs. Seven species of adult worms were recovered and differentiated. These were *H. contortus*, *T. axei*, *T. colubriformes*, *B. trichocephalum*, *O. columbianum*, *O. venulosum* and *T. ovis* (Table 2).

*H. contortus* and *Trichostrongylus* spp were the most prevalent and were recovered from all the animals. Multiple infections were common and more that two species of worms were recovered from each animal. The main worms recovered from the abomasum were *H. contortus* and *T. axei* while *T. colubriformes* and *B.*
*trigonocephalum* were recovered from the small intestines. Two animals had adult *Moniezia expanza* in the small intestines. *O. venulosum* and *O. columbianum* were recovered from the large intestines. Few *T. ovis* were also recovered from the caecum (Table 2).

**Discussion**

This study showed that helminthosis affects small ruminants in Turkana District. The level of infection varies with seasons. The animals were heavily infected during the wet season. Seasonal variation in the

**Table 1**: Arithmetic mean faecal egg counts for sheep and goats by season and age.

<table>
<thead>
<tr>
<th>Species</th>
<th>Season / Age</th>
<th>Mean epg ± SD</th>
<th>P - Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Raw</td>
<td>Log transformed</td>
<td></td>
</tr>
<tr>
<td>Goats N= 546</td>
<td>Dry</td>
<td>269 ± 30</td>
<td>2.43 ± 0.45</td>
</tr>
<tr>
<td></td>
<td>Rainy</td>
<td>562 ± 32</td>
<td>2.75 ± 0.46</td>
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<tr>
<td></td>
<td>Young N= 51</td>
<td>977 ± 22</td>
<td>2.99 ± 0.35</td>
</tr>
<tr>
<td></td>
<td>Mature N= 495</td>
<td>355 ± 33</td>
<td>2.55 ± 0.47</td>
</tr>
<tr>
<td>Sheep N= 560</td>
<td>Dry</td>
<td>437 ± 26</td>
<td>2.64 ± 0.42</td>
</tr>
<tr>
<td></td>
<td>Rainy</td>
<td>1000 ± 22</td>
<td>3.00 ± 0.34</td>
</tr>
<tr>
<td></td>
<td>Young N= 54</td>
<td>1549 ± 16</td>
<td>3.19 ± 0.21</td>
</tr>
<tr>
<td></td>
<td>Mature N= 506</td>
<td>576 ± 26</td>
<td>2.76 ± 0.42</td>
</tr>
</tbody>
</table>

**Table 2**: Percentage prevalence (PP) of nematodes identified at slaughter (N=22).

<table>
<thead>
<tr>
<th>Adult nematode</th>
<th>Number examined</th>
<th>Number positive</th>
<th>PP</th>
<th>Mean burden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abomasum <em>H. contortus</em></td>
<td>22</td>
<td>22</td>
<td>100</td>
<td>789</td>
</tr>
<tr>
<td>T. axei</td>
<td>22</td>
<td>22</td>
<td>100</td>
<td>578</td>
</tr>
<tr>
<td>Small intestines</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>T. columbiformes</em></td>
<td>22</td>
<td>22</td>
<td>100</td>
<td>458</td>
</tr>
<tr>
<td><em>B. trigonocephalum</em></td>
<td>22</td>
<td>16</td>
<td>72.7</td>
<td>48</td>
</tr>
<tr>
<td>Large intestines</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>O. columbianum</em></td>
<td>22</td>
<td>17</td>
<td>77</td>
<td>22</td>
</tr>
<tr>
<td><em>O. venulosum</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>T. ovis</em></td>
<td>22</td>
<td>1</td>
<td>4.5</td>
<td>0.1</td>
</tr>
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</table>
prevalence and intensity of gastrointestinal nematode infections observed in this study
has been reported by earlier workers. In these reports prevalence measured by faecal egg counts or total
worm burdens followed rainfall patterns. In a study in southern Mauritania, season
was found to be most the important factor influencing strongyle egg output in sheep
and goats. Rainy season was the most favourable while dry season was the
least. In the present study rainy season, was associated with increased faecal egg
output. The wet season is associated with accelerated hatching of nematode eggs
and improved survival of infective larvae resulting to heavy pasture infection. Para-
sitic gastroenteritis has been found to be a significant problem in sheep and goats
in all agroclimatic zones in Kenya. It is also a major constraint to improvement of
goat breeds in Western Kenya.

Haemonchus contortus has been reported to be the most prevalent nematode
species in many parts of the world. It is the most economically important
nematode in small ruminants in Kenya. Similar results have been obtained in Zim-
babwe, eastern Nigeria and southern Nigeria.

Hypobiosis involving *H. contortus* has been reported in some semi-arid areas of
Kenya. Hypobiosis may have been a possibility in this study and may have ac-
counted for the higher egg counts during the rainy season. Hypobiosis has also
been reported in Zimbabwe, Southern Mauritania and Saudi Arabia.

Other nematodes recovered from coprocultures and postmortem included
Trichostrongylus spp, *B. trigonocephalum*, *Oesophagostomum* spp and *T. ovis*. This
is the first report on the occurrence of the hookworm *B. trigonocephalum* in the arid
and semi-arid areas of Kenya. *Oesophagostomum* spp has been re-
ported to be a major cause of condemnation of intestines due to "pimply gut" in
selected abattoirs around Nairobi. Though it may not have an impact in the
study area, it may have an impact in the future with the expansion of the livestock
and livestock product markets outside the district.

This study has further confirmed the results of earlier workers that sheep and
goats share the same nematode para-
sites. This means that sheep and goats
cannot be rotated in an alternative graz-
ing system in this area. Sheep carry a
heavier burden than goats. This has
been partly attributed to their feeding hab-
its goats being mainly browsers. Sheep
have been shown to graze closer to the
ground hence pick more infective lar-
vae.

In this study most infections were ac-
cquired at the watering points where there
was vegetation throughout the year. This
supported the survival of the infective lar-
vae.

From this study it was concluded that
gastrointestinal nematodes affect the health and production of small ruminants
in the semi-arid Turkana district. *Haemon-
chus contortus* was the main species in-
festing the small ruminants. The presence
of the hookworm *B. trigonocephalum* to-
gether with *H. contortus* is a likely cause of
fatal parasitic gastroenteritis. The presence
of the hookworm *B. trigonocephalum*, *H.
contortus* and the poor quality feeds and
the harsh environmental conditions may
be the most important factors affecting the
health and productivity of small ruminants
in Turkana.
Acknowledgement

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CHARACTERIZATION OF ESCHERICHIA COLI ISOLATED FROM POULTRY IN ZARIA, NIGERIA

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CARACTERISATION DES ISOLATS DE ESCHERICHIA COLI ISELES DES VOLAILLES A ZARIA AU NIGERIA

Résumé

Vingt (20) isolats de Escherichia coli ont été obtenus de 98 prélèvements sur divers organes des volailles à la nécropsie à l'Université Ahmadu Bello entre avril 1995 et février 1999. Les isolats étaient recueillis des prélèvements du péricarde, du foie, etc. caractérisés à l'aide des tests biochimiques normalisés. Des travaux de sérotypage étaient effectués avec les tests d'agglutination sur lame. Parmi les isolats de E. coli sérotypes, seuls quatre pouvaient être typés dont deux du sérogroupe 08, une souche aviaire pathogène connue. Aucun des isolats de E. coli n’était hémolytique, alors que 35% (7/20) était positif à l’absorption de la "Congo red dye". La sensibilité antimicrobienne a exposé 4 antibiogrammes et des taux élevés (60 - 100%) de résistance à la céphalothine, à la pénicilline, à la tétracycline, à la streptomycine et à la sulfaméthoxade - trimethoprim. Tous les isolats étaient sensibles au chloramphénicol, à l'amoxicilline et à l'ampicilline. L'étude a révélé que E. coli est la cause principale de la morbidité et de la mortalité aviaires.

Mots - clés : E. coli, caractérisation, volaille, nécropsie, sérotypage, antibiogrammes.

Summary

Twenty (20) Escherichia coli isolates were obtained from a total of 98 swabs taken from various organs of poultry at post mortem submitted to the A.B.U University between April 1995 and February 1999. The isolates were from samples of pericardium, liver, etc characterized using standard biochemical tests. Serotyping work was done by standard slide agglutination tests. From the E. coli isolates serotyped, only four (4) isolates were typeable, of which two (2) were of serogroup 08, a known pathogenic avian strain. None of the E. coli isolates was hemolytic while 35%, (7/20) were positive for Congo red dye uptake. Antimicrobial susceptibility revealed four (4) antibiograms and high percentages (60-100%) of resistance to cephalothin, penicillin, tetracycline, streptomycin and sulphamethoxade-trimethoprin. All the isolates were susceptible to chloramphenical, amoxicillin and ampicillin. The study showed that E. coli is an important cause of avian morbidity and mortality.

Key words: E. coli, Characterization, Poultry, Post mortem, Serotyping Antibiograms.

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Introduction

*Escherichia coli* is an important cause of morbidity and mortality in poultry, causing significant economic losses to poultry industry\(^1\). Infection in turkeys and chickens is manifested in several forms, the most common being colibacillosis, which is characterized in the acute form by septicemia resulting in death and in the subacute form by air sacculitis, pericarditis and perihepatitis\(^2\). The infection is often secondary to viral and mycoplasmal agents and to environmental stress\(^3\).

The most common isolated serotypes worldwide include 01, 02, 078, and 035, even though a high prevalence of untypeable strains are frequently encountered\(^4,5,6\). In addition to the involvement of specific serotypes in the epidemiology of avian colibacillosis, certain virulent phenotypes of avian pathogenic strains have been identified\(^7\).

The growth of the poultry industry in Nigeria has been hampered by several factors including diseases\(^8\). Colibacillosis has been identified as a significant disease of poultry in Nigeria\(^9,10\). Similarly, *E. coli* has been found to be the most frequently isolated bacterium in poultry, in particular, chronic respiratory disease\(^11,12\).

Much of the information on colibacillosis in poultry in Nigeria are derived from retrospective submissions of dead birds. There is therefore the need to determine the serotypes of *E. coli* commonly associated with avian colibacillosis in Nigeria.

Moreover, the continued surveillance of major diseases of poultry is desirable, as this will ensure availability of information, which can be used in planning control measures\(^9,10\). In addition, there is need to monitor the spectrum of bacterial resistance from animals and food, since the resistance to drugs encountered in human bacterial agents may emanate from animals\(^13,14\). This information is also obviously of value in the rational management of avian colibacillosis.

This study was conducted to: isolate, characterize, biochemically and serotype *E. coli* from suspected cases of avian colibacillosis and other avian diseases in Zaria; to determine the susceptibility of the isolates to a panel of ten antimicrobial agents; and determine the hemolytic characteristics and ability of the isolates to bind Congo red dye.

Material and Methods

Sampling

A total of 98 records of swab samples presented to the Poultry Unit of the Veterinary Teaching Hospital, Ahmadu Bello University, Zaria, Nigeria, from April 25, 1995 to February 18, 1999 the samples were obtained from the pericardium, liver, spleen, trachea, air and yolk sacs of birds that were used in this study. The birds from which the swabs were taken had clinical history and pathologic diagnoses suggestive of colibacillosis and other poultry diseases. The swabs, taken over a 4 year period, were from freshly necropsied birds and placed in 2 ml of nutrient broth and transported to the laboratory immediately for examination.

Bacterial culture

Samples were processed within six hours of arrival in the laboratory using standard methods\(^15\). Swabs that could not be plated on culture medium immediately were refrigerated at 5°C. The swabs were processed by making a smear on MacConkey agar and streaked in at least three directions using a Pasteur loop to obtain isolated colonies and incubated at
37°C for about 24 h. One or more lactose fermenting colonies growing on the isolation medium were picked onto nutrient agar slants in Bijoux bottles. The bottles were incubated overnight at 37°C and stored at 4°C in a refrigerator.

Biochemical identification and characterization
Identification and characterization of bacterial cultures were undertaken as previously reported\textsuperscript{16,15}. Briefly, cultures stored in nutrient agar slants were inoculated on MacConkey agar to ensure viability and purity. Preliminary screening was determined by reactivities of cultures in MRVP, simmons citrate, and production of indole. Isolates that produced reactions suggestive of \textit{E. coli} were further characterized using the following tests and substrates: motility, \textsubscript{H} \textsubscript{2} \textsubscript{S} production, esculin hydrolysis, phenylalanine deaminase, gelatin liquefaction, urease production, and fermentation of lactose (and gas production), galactose, glucose, sucrose, sorbitol, rhamnose and salicin.

Serotyping
The identification of the O somatic and K capsular antigens were carried out at the Onderstepoort Veterinary Institute, Onderstepoort 0110, South Africa by standard slide agglutination tests\textsuperscript{17,18}.

Hemolysin assay
Plates of Tryptic Soy Agar containing 5% sheep blood (RBC) were inoculated with test strains, incubated at 37°C for 24 h and examined for clear zone of hemolysis around bacterial colonies\textsuperscript{5}.

Uptake of Congo red dye
The ability of \textit{E. coli} isolates to bind unto Congo red dye was determined as previously described\textsuperscript{19}, and interpreted by the method of Kabili and Sharma\textsuperscript{20}. In brief, a single isolated colony of each test bacteria was streaked onto TSA supplemented with 0.03% Congo red dye and 0.15% bile salts. The plates were incubated at 37°C for 24 h and then left for a further 48 h at room temperature to visualize the red or pink positive colonies.

Antimicrobial susceptibility testing
All isolates of \textit{E. coli} were tested for susceptibility to ten antimicrobial agents by the standardized single disk method on Mueller Hinton agar plates\textsuperscript{21}. The plates were incubated at 37°C for 18 h and zones of inhibition were measured to the nearest millimeter. The antimicrobial agents (Oxoid, Basingstoke, U.K.) and their disk concentrations were ciprofloxacin (5 mg), sulphamethoxazole-trimethoprin (25 mg), streptomycin (10 μg), penicillin (30 μg), ampicillin (10 μg), and amoxycillin (25 μg). Interpretations were based on the recommendations of the manufacturers.

Results
Out of the 98 samples examined, \textit{E. coli} were isolated in 20 representing an isolation rate of 20.4%. \textit{Escherichia coli} had the following characteristics: on TSI, acid over acid with gas, \textsubscript{H} \textsubscript{2} \textsubscript{S} negative, motile, indole positive, citrate negative, methyl red positive, Voges-Proskauer negative, urease negative, phenylalanine deaminase negative, esculin negative, negative for salicin, and positive for lactose (gas), galactose, glucose, sucrose, sorbitol and rhamnose. Whereas 35% (7/20) of the isolates were positive for Congo red dye binding, none was \textbeta;-hemolytic on 5% sheep blood agar (Table 1). Only four out of 20 of the isolates were typeable, these were 08,076 and 0149 (Table 1).
Table 1: Characteristics of *E. coli* isolates from poultry at post-mortem

<table>
<thead>
<tr>
<th>Serial</th>
<th>Isolate</th>
<th>Serotype</th>
<th>Congo red dye uptake</th>
<th>Species</th>
<th>Breed</th>
<th>Swab</th>
<th>Clinical/necropsy diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7668</td>
<td>NT*</td>
<td>-</td>
<td>Chicken</td>
<td>Improved</td>
<td>Trachea</td>
<td>Fowl cholera</td>
</tr>
<tr>
<td>2</td>
<td>7869</td>
<td>NT</td>
<td>-</td>
<td>Falcon</td>
<td>Wild</td>
<td>Liver</td>
<td>Avian malaria</td>
</tr>
<tr>
<td>3</td>
<td>7893</td>
<td>08:K45</td>
<td>-</td>
<td>Chicken</td>
<td>Improved</td>
<td>Air sac</td>
<td>Colibacillosis</td>
</tr>
<tr>
<td>4</td>
<td>7549</td>
<td>NT</td>
<td>-</td>
<td>Chicken</td>
<td>Local</td>
<td>Gall bladder</td>
<td>Pullorum disease</td>
</tr>
<tr>
<td>5</td>
<td>7621</td>
<td>0149:K91</td>
<td>+</td>
<td>Chicken</td>
<td>Improved</td>
<td>Liver</td>
<td>Vitamin A deficiency</td>
</tr>
<tr>
<td>6</td>
<td>8160</td>
<td>NT</td>
<td>-</td>
<td>Chicken</td>
<td>Improved</td>
<td>Liver</td>
<td>Colibacillosis</td>
</tr>
<tr>
<td>7</td>
<td>7667</td>
<td>NT</td>
<td>-</td>
<td>Chicken</td>
<td>Improved</td>
<td>Liver</td>
<td>Nutritional deficiency</td>
</tr>
<tr>
<td>8</td>
<td>8180</td>
<td>08:K44</td>
<td>-</td>
<td>Chicken</td>
<td>Improved</td>
<td>Liver</td>
<td>Colibacillosis</td>
</tr>
<tr>
<td>9</td>
<td>7745</td>
<td>NT</td>
<td>-</td>
<td>Chicken</td>
<td>Improved</td>
<td>Liver</td>
<td>Coccidiosis</td>
</tr>
<tr>
<td>10</td>
<td>7709</td>
<td>NT</td>
<td>-</td>
<td>Chicken</td>
<td>Improved</td>
<td>Liver</td>
<td>Gumboro disease</td>
</tr>
<tr>
<td>11</td>
<td>8140</td>
<td>NT</td>
<td>-</td>
<td>Chicken</td>
<td>Improved</td>
<td>Liver</td>
<td>Colibacillosis</td>
</tr>
<tr>
<td>12</td>
<td>7627</td>
<td>NT</td>
<td>-</td>
<td>Chicken</td>
<td>Improved</td>
<td>Trachea</td>
<td>Fowl cholera</td>
</tr>
<tr>
<td>13</td>
<td>7593</td>
<td>NT</td>
<td>-</td>
<td>Chicken</td>
<td>Improved</td>
<td>Liver</td>
<td>Colibacillosis</td>
</tr>
<tr>
<td>14</td>
<td>7634</td>
<td>NT</td>
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<td>Chicken</td>
<td>Improved</td>
<td>Liver</td>
<td>Gumboro disease</td>
</tr>
<tr>
<td>15</td>
<td>7552</td>
<td>NT</td>
<td>+</td>
<td>Turkey</td>
<td>Local</td>
<td>Trachea</td>
<td>Fowl cholera</td>
</tr>
<tr>
<td>16</td>
<td>8190</td>
<td>NT</td>
<td>+</td>
<td>Chicken</td>
<td>Improved</td>
<td>Liver</td>
<td>Colibacillosis</td>
</tr>
<tr>
<td>17</td>
<td>7536</td>
<td>NT</td>
<td>+</td>
<td>Chicken</td>
<td>Improved</td>
<td>Gall bladder</td>
<td>Newcastle disease</td>
</tr>
<tr>
<td>18</td>
<td>7640</td>
<td>NT</td>
<td>+</td>
<td>Chicken</td>
<td>Improved</td>
<td>Liver</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>19</td>
<td>8201</td>
<td>07:K</td>
<td>-</td>
<td>Chicken</td>
<td>Improved</td>
<td>Liver</td>
<td>Colibacillosis</td>
</tr>
<tr>
<td>20</td>
<td>8083</td>
<td>NT</td>
<td>-</td>
<td>Pea cock</td>
<td>Wild</td>
<td>Liver</td>
<td>Colibacillosis</td>
</tr>
</tbody>
</table>

* = Non-typeable.

All the 20 isolates were susceptible to ciprofloxacin (CIP), ceftriaxone CRD, while 90% were susceptible to chloramphenicol (C), amoxyccillin (AML) and ampicillin (AMP). All isolates were found to be resistant to cephalothin (KF) and penicillin (P). A significant proportion were resistant to tetracycline (TE) (75%), and streptomycin (S) (65%) and sulphamethazole-trimethoprim (SXP) (60%). The details of the susceptibility of the isolates are provided in Table 2. Altogether, only four patterns of resistance or antibiograms were observed, i.e. KF, TE, S, P, SXT; KF, P; KF, TE, AML, S, AMP, P, SXT; and KF, C, TE, T, SXT, were encountered 11, 5, 2, and 2 times respectively.
Table 2: In vitro susceptibilities of 20 avian *Escherichia coli* isolates to 10 antimicrobial agents.

<table>
<thead>
<tr>
<th>Serial number</th>
<th>Antimicrobial agents</th>
<th>No. (%) susceptible</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ciprofloxacin (CIP)</td>
<td>20 (100)</td>
</tr>
<tr>
<td>2</td>
<td>Cephalothin (KD)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>3</td>
<td>Chloromphenicol (C)</td>
<td>18 (90)</td>
</tr>
<tr>
<td>4</td>
<td>Tetracycline (TE)</td>
<td>5 (25)</td>
</tr>
<tr>
<td>5</td>
<td>Amoxycillin (AML)</td>
<td>18 (90)</td>
</tr>
<tr>
<td>6</td>
<td>Streptomycin (S)</td>
<td>7 (35)</td>
</tr>
<tr>
<td>7</td>
<td>Ampicillin (AMP)</td>
<td>18 (90)</td>
</tr>
<tr>
<td>8</td>
<td>Ceftriaxone (CRO)</td>
<td>20 (100)</td>
</tr>
<tr>
<td>9</td>
<td>Penicillin G (P)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>10</td>
<td>Sulphamethaxazole-trimethoprim (SXT)</td>
<td>8 (40)</td>
</tr>
</tbody>
</table>

Discussion

This study reports on the characterization of *E. coli* isolated from poultry suspected with colibacillosis and other conditions at post mortem. A total of 20 *E. coli* isolates were confirmed from the samples examined. Only four of the isolates were typeable and belonged to serogroups 08, 076 and 0149. This may be one of the few studies on the serotypes of *E. coli* of poultry origin in Northern Nigeria. Previous reports in Southern Nigeria have documented various serotypes from poultry, including 01, 02, 078, 0138, and 0141.

Of the serogroups encountered in the present study, 08 serogroup is considered to be an avian pathogenic strain. This serogroup has also been isolated from poultry in Zaria (Raji, M.A.; unpublished report), and Zambia and in calves. About 80% of the isolates were untypeable. Previous studies in Zambia and Canada have reported 76% and 39% of isolates respectively to be untypeable. It has been observed that many pathogenic isolates do not belong to known serotypes or are untypeable.

Several factors including antibiotic resistance, serotypes, cytotoxins, motility and Congo red dye uptake have been found to correlate with virulence of *E. coli* in poultry. In the present study, none of the isolates was hemolytic on 5% sheep RBC, a finding which is in accordance with a past report. Of the 20 isolates tested, 17 (85%) were motile. According to Barnes and Gross, no single factor identifies all virulent strains, and conflicting correlation between most factors and virulence have been found.

The ability of avian *E. coli* strains to take up Congo red dye has been identified as a virulence attribute, although there could be inconsistency in findings. Congo
red dye binding probably identifies a subset of avian colisepticemic *E. coli*, but is not a market for pathogenicity. In the present study, 35% of the isolates were positive for this phenotype. This is much lower than the 100% rates reported earlier\(^5\), but similar to the 40% reported by Raji, M.A. for clinical isolates (unpublished report). The differences observed may be related to the inconsistencies noted in the outcome of the test\(^9\), or the subsets of the *E. coli* strains tested. It appears from the results obtained for these putative virulence factors that no single factor may correlate with virulence in the isolates examined in the present study. Rather the totality of factors in conjunction with *in vivo* test should be taken into account in confirming the virulence status of avian *E. coli* strains.

The antimicrobial susceptibility testing of the isolates to 10 agents revealed that all isolates were susceptible to ciprofloxacin and ceftriaxone, and resistant to cephalothin, and penicillin G. The susceptibility of all or most of the isolates to fluoroquinolones, chloramphenicol and ampicillin, and the high prevalence of resistance to cephalothin, penicillin, tetracycline, streptomycin and sulphamethaxazole-trimethoprim are largely in agreement with previous studies\(^5,20,28\). The results of this study lends support that antimicrobial resistance is prevalent in avian *E. coli*. Since the resistance to drugs encountered in human bacterial agents may emanate from animals, there is the need to monitor continuously the spectrum of antibiotic resistance in animal and food\(^13,14\).

This study established that *E. coli* is a significant post mortem isolate from cases of poultry diseases in the study area. This is in agreement with previous studies in Zaria where *E. coli* was the most frequently iso-

lated organism in chickens and in cases of chronic respiratory disease\(^11,12\). Colibacillosis has been identified to be a leading cause of morbidity and mortality in poultry, in Nigeria\(^9,10\). *E. coli* causes different disease syndromes in poultry and causes significant economic losses to the industry\(^4\). The avian pathogenic isolates are clonal in nature belonging to certain genetic background\(^29,30\). Various multifaceted approaches with emphasis on management systems and vaccinations have been considered\(^7,26\).

In summary, though a high percentage of untypeable strains were documented, it does not exclude their role as agents of colibacillosis or other syndromes. The antibiograms of the isolates suggest a high prevalence of antibiotic resistance among the test strains. In order to gain a broader perspective on the extent of colibacillosis and the nature of *E. coli* strains involved in poultry, there is a need for broader study involving other locations, more samples, additional virulence phenotypes and *in vivo* pathogenicity assessment of isolates.

**Acknowledgements**

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**References**

Characterization of Escherichia coli isolated from poultry in Zaria, Nigeria.


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STUDIES ON SOME ASPECTS OF REPRODUCTIVE BIOLOGY OF SOME IMPORTANT FISH SPECIES IN LAKE ALAU IN BORNO STATE, NIGERIA

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ETUDES SUR CERTAINS ASPECTS DE LA BIOLOGIE REPRODUCTIVE DE QUELQUES ESPÈCES IMPORTANTES DE POISSON DANS LE LAC ALAU DANS L'ETAT DE BORNO AU NIGERIA

Résumé

Pendant les quatre mois qu'a duré l'étude (avril à juillet 1993), au total 67 poissons femelles appartenant à trois familles différentes (Characidae, Schilbeidae et Cichlidae) étaient recueillies d'un lac naturel dans le nord-est du Nigeria, en vue d'étudier certains aspects de la biologie reproductive, y compris l'indice gonado - somatique, la fécondité et le diamètre de l'œuf, qui permettent de tirer une conclusion sur la capacité à frayer, la saison de frai et le comportement de ces espèces.

Summary

During the 4 months of study period from April to July, 1993 a total of 67 female fishes from three different families (Characidae, Schilbeidae and Cichlidae) were collected from a natural lake in north-eastern region of Nigeria for study of some aspects of reproductive biology including gonado-somatic index, fecundity and ova diameter which lead to conclusion about the spawning capacity, time and behaviour of these species.

Introduction

Fisheries is now considered as one of the important sources of agricultural products for supplying the cheapest animal protein to meet the increasing global demand. In Nigeria, culture and capture fisheries occupy a unique position in the agricultural sector, with fish contributing a major portion of the animal protein intake of the average Nigerian. The interest in fish culture has now increased to provide the much needed protein supply for the Nigerian population. But in Borno State, which falls in the semi-arid zone, the prospect of fish culture is very low and people have to depend solely on the capture fisheries from natural water bodies like Lake Chad, Lake Alau and some seasonal rivers. Lake Chad fisheries supplies a high amount of fish to Maiduguri market, while the Lake Alau fisheries supplies fresh and live fishes. Lake Alau fishes constitute 90% of the fresh fish marketed in Maiduguri, the capital of Borno State, because of the technical difficulties of bringing fresh fish from Lake Chad which is situated 50 km in the north east extreme of Borno State.

It is now a realized fact that the development of fisheries has to be preceded by careful management of both culture and capture fisheries. Rational and scientific
management of fisheries depends on the fundamental understanding of fish biology and ecology. Study of reproductive parameters is one of the most essential parts of fisheries management. Among the various biological aspects of fish, the fecundity, gonadosomatic index, egg-diameter, maturation stages, spawning frequency and spawning period are important for management of both culture and capture fisheries.

In Africa, many authors have documented the fecundity and some other aspects of the reproductive biology of number of freshwater fishes. Egg production capabilities were studied in relation to gonadosomatic index and egg sizes of a group of species from different families in Ogun River, Nigeria while the maturity, fecundity and spawning of *Hilsa ilisha*, a migratory fish, have been studied in river Ganga in India.

In the present work, study of fecundity, gonado-somatic index and ova-diameter of some economically important fish species found in Lake Alau, Borno State, Nigeria were made to determine the breeding behaviour of the species prior to their spawning season which is essential for appropriate fisheries management practices.

**Materials and Methods**

**Study Area**

Borno State situated in northeastern Nigeria is located between 10° 20'-13° 40' N and 9° 40' - 140° 50' E. Borno State has Sudan savanna vegetation zone and partly Sahel zone characterized by a short rainy (wet) season (July to September, 1993) with high temperature during the dry period (mean maximum temp. 33.1°C) which reaches above 40°C in the hot dry season (March-June). The erratic and unpredictable nature of rainfall accompanied with high evaporation gives Borno a poor climate. The state is also known to be richly endowed with water resources based on Lake Chad, Lake Alau and rivers like Chari and Ngadda. These are known as life giving resources of the people in this environment.

**Lake Alau**

Lake Alau, believed to be a remnant of the former mega Lake Chad, is in a basin situated approximately 20 km southeast of Maiduguri, the capital of Borno State. Though Lake Alau is situated in a zone of unpredictable climatic environment, experiencing frequent climatic changes, it has continued to exist. Lake Alau receives an annual delivery of water from Ngadda and Yedzeram river systems which are seasonal rivers feeding lake Alau in the rainy season on their way to Lake Chad.

**Study period**

The sampling was made during the period from April to July, 1993. This study period was selected because the fish under study usually spawn during rainy season, *Alestes* during July to September, 1993 and *Schilbe*, during July to August, 1993. *Alestes nurse* were collected once a month from April to June and were not found among the catch later during the sample collection. *Schilbe mystus* were collected from May to July, 1993 whereas *Sarotherodon galilaeus* were collected from April to July except in May due to non-availability among the catch during sampling.

**Study material**

Apart from *Clarias*, the other most common fish species found in Lake Alau include the *Alestes* spp. *Schilbe* spp. and *tilapias*. The species studied in this work
are *Alestes nurse*, *Schilbe mystus* and *Sarotherodon galilaeae* representing three different families namely *Characidae*, *Schilbeidae* and *Cichlidae* respectively.

**Collection, identification and laboratory investigation of selected fishes**

Gill nets and cast nets were used in catching the fish from Lake Alau. The fish, which were caught using gill nets and cast nets, were identified and immediately transported live in a container with water to the laboratory for analysis. The identification was made according to the authors\textsuperscript{13,14}, a brief description of which is as follows.

**Alestes nurse**

Elongated fusiform body with cycloid scale and no scale on the head. Well-developed rayed fins and small dorsal adipose fin. Lateral line along the lower side of the flank.

**Family Characidae**

Teeth with cusps, small adipose fin, nostrils closed together near the eyes; Anal fin convex in males and concave or straight in females.

**Genus Alestes**

Rather compressed body with red tail. Dorsal fin originating opposite base of ventral. Dorsal fin with 10 rays; Anal fin 14-18; 27-32 scales in the lateral line.

**Schilbe mystus**

Very compressed body naked of scales. Mouth with four pairs of long hair like unbranched burbels and a pair of nasal burbels. Rayed dorsal fin short, anal fin very long.

**Family Schilbeidae**

Rayed dorsal fin with a sharp denticu-
Table 1. Body weight total length, gonad weight, GSI, fecundity, relative fecundity and ova-diameter of *Alestes nurse*, *Schilbe mystus* and *Sarotherodon galilaeae* from Lake Alau. The mean values are shown in parentheses.

<table>
<thead>
<tr>
<th>Family</th>
<th>Number Examined</th>
<th>Body weight (G)</th>
<th>Total length (CM)</th>
<th>Gonad weight (G)</th>
<th>GSI</th>
<th>Fecundity</th>
<th>Relative fecundity</th>
<th>Ova-diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characidae</td>
<td>17</td>
<td>81.5-105.07</td>
<td>18.3-20.8</td>
<td>0.77-11.25</td>
<td>0.86-10.93</td>
<td>8617-77464</td>
<td>82-746</td>
<td>15.4-26.6</td>
</tr>
<tr>
<td>Alestes nurse</td>
<td></td>
<td>(93.73)</td>
<td>(19.38)</td>
<td>(4.44)</td>
<td>(4.64)</td>
<td>(25156)</td>
<td>(263)</td>
<td>(22.09)</td>
</tr>
<tr>
<td>Schilbeidae</td>
<td>31</td>
<td>62.0-128.0</td>
<td>19.0-24.2</td>
<td>0.40-15.09</td>
<td>0.65-11.78</td>
<td>1565-53511</td>
<td>19-418</td>
<td>17.3-32.4</td>
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<tr>
<td>Schilbe mystus</td>
<td></td>
<td>(88.14)</td>
<td>(21.37)</td>
<td>(6.21)</td>
<td>(6.775)</td>
<td>(15334)</td>
<td>(158)</td>
<td>(26.21)</td>
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<tr>
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<td>19</td>
<td>44.06-106.04</td>
<td>13.5-17.6</td>
<td>0.06-4.01</td>
<td>0.14-4.22</td>
<td>41-634</td>
<td>0.72-61</td>
<td>13.1-92.8</td>
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<tr>
<td>Cichlidae</td>
<td></td>
<td>(72.55)</td>
<td>(15.32)</td>
<td>(0.69)</td>
<td>(0.84)</td>
<td>(198)</td>
<td>(2.42)</td>
<td>(37.14)</td>
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<tr>
<td>Sarotherodon galilaeae</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Mean body weight, total length, GSI, fecundity and relative fecundity of three fish species studied in each month.

<table>
<thead>
<tr>
<th>Family</th>
<th>Mean Body Weight (G)</th>
<th>Mean Total Length (CM)</th>
<th>Mean GSI</th>
<th>Mean Fecundity</th>
<th>Mean Relative Fecundity</th>
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<tbody>
<tr>
<td>A. nurse</td>
<td></td>
<td></td>
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<tr>
<td>APRIL</td>
<td>94.543</td>
<td>19.66</td>
<td>1.31</td>
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<tr>
<td>MAY</td>
<td>92.183</td>
<td>19.17</td>
<td>3.693</td>
<td>16855</td>
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<tr>
<td>JUNE</td>
<td>96.975</td>
<td>19.7</td>
<td>9.488</td>
<td>59286</td>
<td>607</td>
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<tr>
<td>JULY</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>S. mystus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>MAY</td>
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<td>26052</td>
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</tr>
<tr>
<td>S. galilaeae</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>APRIL</td>
<td>76.47</td>
<td>15.37</td>
<td>0.69</td>
<td>140</td>
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</tr>
<tr>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>JUNE</td>
<td>56.88</td>
<td>14.38</td>
<td>0.578</td>
<td>84</td>
<td>1.5</td>
</tr>
<tr>
<td>JULY</td>
<td>87.25</td>
<td>16.63</td>
<td>1.588</td>
<td>501</td>
<td>5.7</td>
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</table>
Table 3. The intercept (‘a’), regression coefficient (‘b’) and correlation coefficient (‘r’) between different parameters of (A) *Alestes nourse*, (B) *Schilbe mystus* and (C) *Sarotherodon galilaea*. The results of significance tests are also shown in the table.

<table>
<thead>
<tr>
<th></th>
<th><em>Alestes nourse</em></th>
<th></th>
<th><em>Schilbe mystus</em></th>
<th></th>
<th><em>Sarotherodon galilaea</em></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>a</td>
<td>b</td>
<td>r</td>
<td>t</td>
<td>a</td>
</tr>
<tr>
<td>Body Wt. / Gonad Wt</td>
<td>-12.069 (***</td>
<td>0.176 (**</td>
<td>0.456 (**</td>
<td>1.986 ***</td>
<td>0.183 (**</td>
</tr>
<tr>
<td>Body weight / GSI</td>
<td>-8.326 (***</td>
<td>0.138 (**</td>
<td>0.366 (**</td>
<td>1.525 ***</td>
<td>3.391 (**</td>
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<tr>
<td>Body Wt. / Ova diameter</td>
<td>20.292 (**</td>
<td>0.019 (**</td>
<td>0.054 (**</td>
<td>0.210 ***</td>
<td>16.41 (**</td>
</tr>
<tr>
<td>Body Wt. / Fecundity</td>
<td>-66503 (***</td>
<td>983.6 (**</td>
<td>0.391 (**</td>
<td>1.644 ***</td>
<td>-24576 (**</td>
</tr>
<tr>
<td>Total length / Gonad Wt</td>
<td>-25.77 (**</td>
<td>1.559 (**</td>
<td>0.370 (**</td>
<td>1.542 ***</td>
<td>35.768 (**</td>
</tr>
<tr>
<td>Total length / GSI</td>
<td>-19.445 (**</td>
<td>1.242 (**</td>
<td>0.302 (**</td>
<td>1.225 ***</td>
<td>-21.299 (**</td>
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<tr>
<td>Total length / Ova diameter</td>
<td>22.06 (**</td>
<td>0.0003 (***</td>
<td>0.000 (***</td>
<td>0.000 ***</td>
<td>2.359 (**</td>
</tr>
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<td>Total length / Fecundity</td>
<td>-141770 (**</td>
<td>8639.4 (**</td>
<td>0.314 (**</td>
<td>1.283 ***</td>
<td>55062 (**</td>
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<td>Gonad Wt. / Ova diameter</td>
<td>20.022 (**</td>
<td>0.459 (**</td>
<td>0.509 (**</td>
<td>2.290 ***</td>
<td>22.89 (**</td>
</tr>
<tr>
<td>Gonad Wt / Fecundity</td>
<td>-2368.8 (***</td>
<td>6319.4 (**</td>
<td>0.969 (**</td>
<td>15.28 ***</td>
<td>2603 (**</td>
</tr>
<tr>
<td>GSI / Ova diameter</td>
<td>19.766 (**</td>
<td>0.494 (**</td>
<td>0.536 (**</td>
<td>2.461 ***</td>
<td>21.91 (**</td>
</tr>
<tr>
<td>GSI / Fecundity</td>
<td>-4128.7 (**</td>
<td>6429.6 (**</td>
<td>0.9643 (**</td>
<td>14.12 ***</td>
<td>2052.6 (**</td>
</tr>
</tbody>
</table>

* P ≤ 0.05;  ** P ≤ 0.01;  *** P ≤ 0.001.
Figure 1. Relationship and regression lines drawn between different parameters of *Alestes nurse*.
Figure 2. Relationship and regression lines drawn between different parameters of *Schilbe mystus*.
Figure 3. Relationship and regression lines drawn between different parameters of *S. galilaeae*.
Figure 4: Frequency distribution of ova-diameter showing gradual increase in egg size with increasing GSI in (A) Sarotherodon galilaeae, (B) Alestes nurse and (C) Schilbe mystus. (B) and (C) showing single mode of ova-diameter increasing from April to July, but (A) showing two distinct modes with varying maturity stages in each month.
eggs, samples were taken from anterior, middle and posterior region of both ovaries and weighed before preservation in labeled specimen bottle containing Gilson's solution for ova diameter and fecundity studies. Gilson's solution was used to separate the eggs by dissolving other tissues of the ovary. For *Sarotherodon galilaeus* whole ovaries with their small number of eggs were preserved. Then preserved specimens were used to study the ova diameter and fecundity.

The weight of whole ovary was used to determine the gonado-somatic index (GSI) by the formula: GSI = Weight of the gonad / Body weight x 100.

Ova diameters were measured according to the described method\(^\text{15}\) while fecundity was determined by counting the total number of maturing eggs in weighed samples preserved and on the basis of the total weight of the ovaries. The formula used for fecundity estimation can be expressed as:

\[
F = W \times \frac{(N_1+N_2+N_3)}{(W_1+W_2+W_3)}
\]

where F = Fecundity or number of mature ova in each ovary; W = total weight of ovary; \(W_1, W_2, W_3\) = weight of each sub-sample and \(N_1, N_2, N_3\) = ova numbers in each sub-sample.

The absolute fecundity is the total number of mature or maturing ova in two ovaries of a fish specimen.

The data were subjected to statistical analysis to find relationship between different parameters if any. For each analysis 5% level of significance was been used.

**Results**

A total of 151 fishes of 3 different species were collected from Lake Alau during April to July among which 67 were found to be female and were examined for this study. The number of the female *Alestes nurse*, *Schilbe mystus* and *Sarotherodon galilaeus* examined was 17, 31 and 19 respectively.

The size range and mean of body weight, total length and the data for reproductive parameters of these species are shown in Table 1. Table 2 contains the mean values of the parameters studied in each month for the said three fish species.

The intercept (a), regression coefficient (b) and correlation coefficient (r) between different parameters of *Alestes nurse*, *Schilbe mystus* and *Sarotherodon galilaeus* along with the results of significance tests are shown in Table 3.

The relationships and regression lines drawn between different parameters of three species studied are shown in Figures 1, 2 and 3 respectively. Figure 4 shows the frequency distribution of ova diameter of the three species.

**Discussion**

The results obtained showed that the relation of fecundity, egg diameter, gonad weight, as well as gonado-somatic index with the size of fish was different in different species.

In the case of *Alestes*, none of the reproductive parameters were dependent on the body weight or total length of fish but as the GSI, fecundity and ova-diameter were found to increase from April to June irrespective of the size of the fish, it can be said that in all female *Alestes* above a certain size gonad starts maturing as monsoon approaches and so ova-diameter is not dependent on body weight. Again, the single mode of ova diameter in all maturing and mature fish revealed a single breeding season for *Alestes*, which is found to be in
the rainy season in Lake Alau.

*Schilbe*, unlike *Alestes* showed that the reproductive parameters were significantly related with the size of the fish, though they are more strongly related with body weight than the total length. However, like *Alestes*, *Schilbe* also showed an increasing trend in GSI, fecundity as well as egg size from May to July with no such increase in mean body weight of fish. This revealed that the gonad of fish above a certain size starts maturing like *Alestes* as monsoon approaches but there was a linear relationship between body size and gonad size. Like *Alestes*, *Schilbe* also showed a single mode of ova-diameter in all maturing and gradually increasing which reveals a single breeding season during rain.

But in *Sarotherodon galilae*, though the fecundity, gonad weight and GSI was significantly related with body-weight and total length, there was practically no gradual increase in GSI and egg size from April to July. In each month a wide range of GSI as well as ova-diameter were found in these tilapias. This revealed no single breeding season in this fish. Similarly, unlike the other two species, *Sarotherodon* showed two modes of smaller and larger eggs in the frequency distribution of ova-diameter which reveals more than one spawning a year.

This was also confirmed with the low GSI value for this fish. An increase in frequency of spawning is accompanied by a fall in GSI of female and cichlids breed 2-14 times a year. No relationship was found between fecundity and mean ova-diameter among the individuals of same species. In fishes, there is no general tendency for large fish to produce larger eggs; so, fecundity in-
be related to comparatively less degree of parental care and less frequency of spawning. It has been established that the size of eggs of fish is directly related to the amount of care the fish can give to its young ones\textsuperscript{25}. Therefore, the existence of some degrees of parental care in \textit{S. galilae}a and less care in \textit{Alestes nurse} and \textit{Schilbe mystus} is confirmed by a size of the eggs they produce.

**Conclusion**

The breeding behaviour of \textit{Alestes nurse} and \textit{Schilbe mystus} was similar, though egg-producing capacity was higher in \textit{Alestes}. Both of these species showed a single spawning in rainy season and from the GSI and ova-diameter study, it can be said that these species spawn during the rainy season. But the gonads start to mature from May in \textit{Alestes} and from June in \textit{Schilbe}. \textit{Sarotherodon galilae}a, on the other hand breed more than once and has a prolonged breeding season. The egg-producing capacity of \textit{S. galilae}a is also very low.

The regression lines drawn can be used to predict the egg producing capacity of these fish from body weight and GSI. The frequency distribution of ova-diameter and GSI can also be used to predict the breeding season.

A restricted fishing of \textit{Alestes nurse} and \textit{Schilbe mystus} in late hot season and rainy season is suggested for Lake Alau to improve the stock as a future fisheries management.

**References**


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OBSERVATIONS ON THE PATHO-PHYSIOLOGICAL RESPONSES OF PIGS RAISED UNDER INTEGRATED BROILER/PIG PRODUCTION SYSTEM

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Department of Animal Science and Technology, Federal University of Technology, P M B 1526 Owerri, Imo State, Nigeria.

OBSERVATIONS SUR LES REACTIONS PHYSIOPATHOLOGIQUES DES PORCS ELEVES DANS UN SYSTEME DE PRODUCTION INTEGREE POULET DE GRIL/PORC

Résumé

Les paramètres hématologiques, les caractéristiques de la carcasse et des organes internes, et le profil du parasite gastro-intestinal étaient utilisés dans une expérience de 12 semaines afin de déterminer l'effet de la fiente fraîche de poulet sur la physiopathologie des porcs élevés dans un système de production intégré poulet de gril/porc. Douze porcs âgés environ de 10 semaines étaient répartis au hasard en trois groupes de 4 animaux chacun et chaque groupe disposait d'un parc séparé. Le groupe A (TRTA) servait de groupe-témoin et recevait 4% du poids vif en ration commerciale, tandis que le groupe B (TRTB) était servi de 2% du poids vif en ration composée de fientes fraîches de poulet et de déchets alimentaires collectés des poulets de gril regroupés dans la cage au-dessus du parc. Le groupe C (TRTC) était nourri de 2% du poids vif en ration composée de fientes fraîches de poulet et de déchets alimentaires collectés des poulets de gril rassemblés dans la cage, sans les porcs dans le parc "D". Les données sur l'hémocritie et de la concentration d'hémoglobine étaient beaucoup plus élevées (P < 0,05) chez les deux groupes qui ont reçu de fientes de poulet. Le groupe TRTB avait des valeurs totales nettement plus grandes de leucocytes, de lymphocytes, de monocytes et d'éosinophiles. Le rendement à l'abattage de 58,30% obtenu du groupe TRTC était très différent (P < 0,05) des valeurs relevées pour le groupe-témoin. L'épaisseur du lard dorsal était plus mince chez les porcs qui avaient consommé de fientes de poulet.

Mots-clés : Porc, poulet de gril, fiente de volaille, physiopathologie, production intégrée, Nigeria.

Summary

Hematological parameters, carcass and internal organ characteristics, and gastro-intestinal parasite profile were used in a 12 weeks experiment to determine the effect of fresh chicken waste on the patho-physiology of pigs raised under an integrated boiler/pig production system. Twelve pigs aged approximately 10 weeks were randomly divided into three groups of 4 animals each and each group housed in a separate pen. Group A (TRTA) served as control and received 4% of their body weight in commercial ration, while group B (TRTB) received 2% of their body weight in ration and made up with fresh poultry droppings and feed waste from the broilers housed above them. Group C (TRTC) received 2% of their body weight in ration, made up with fresh poultry droppings and feed waste collected from broilers housed without pigs in pen D. Hematology data did not indicate significant treatment effect (P>0.05) on the RBC counts. PCV and HBC values were however significantly (P<0.05) higher in the two groups receiving poultry waste. The TRTB group had significantly higher total WBC, lymphocytes, monocytes and eosinophil values. The 58.30% dressed weight obtained from the TRTC group differed significantly (P<0.05) from the values recorded for the control group. Back fat thickness was thinner among pigs that consumed poultry waste.

Key words: Pig, Broiler, Poultry waste, Patho-physiology, Integrated production, Nigeria.

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Introduction

Global demand for food of animal origin is steadily rising, and is being exacerbated in most developing countries by rising human population and urbanization\(^1\). Urbanization has profound effects on the demand for agricultural products particularly the demand for foods of animal origin from relatively affluent urban families. Thus, the need to match this growth in demand with growth in animal population, especially in urban and peri-urban areas, has to be addressed.

Most peasant farmers in the land limiting urban and peri-urban areas of southeastern Nigeria keep pigs as scavengers mostly because of the high cost of raising them intensively. This production system is marked by low productivity, low survivability of young ones and numerous environmental problems. There is the need therefore to develop low cost intensive management strategies for such resource poor urban farmers. An integrated poultry/pig farming based on recycling of poultry wastes seems to hold some prospects\(^2\).

In Nigeria, utilization of excrements from one animal species for feeding another is still a research issue\(^3\),\(^4\). Recycling of feed resources in an integrated farming system is thus not common in the country for monogastric animal species as it is conceived in many Asian countries. For example, integration of pig production with other ancillary enterprises involving various combinations of fish farming, methane gas generation, algae, ducks, water hyacinth and vegetable production is common in tropical Asia\(^5\),\(^6\),\(^7\). Poultry droppings are usually high in nutritive content, averaging 28% crude protein\(^3\),\(^8\). Satisfactory performance has been reported from feeding poultry wastes to ruminants and poultry\(^3\),\(^9\),\(^10\).

Growth performance and economics of production aspect of this study, which is being published under a separate title, have demonstrated that pigs and finisher broilers could effectively be raised in an integrated production system whereby pigs can pick droppings from broilers housed above them in cages. It is however imperative to understand the possible clinical and pathological implications of recycling such poultry wastes by feeding to pigs\(^11\),\(^12\). The study reported herein was therefore designed to evaluate the effects of consumption of fresh chicken droppings on the hematology, internal organ characteristics and gastro-intestinal parasite profile of pigs raised under an integrated broiler/pig production system.

Materials and methods

Experimental animals

Twelve (12) pigs were used in this study to evaluate the growth performance and economics of production of young growing pigs and finisher broilers under integrated broiler pig production system. At the beginning of the study, the 12 pigs were aged approximately 10 weeks and had body weight range of 13.40 to 14.00 kg. They were divided into three groups of 4 animals each and each group housed in a separate pen. Each pig within a group was tagged and regarded as a replicate.

Group A served as control and received 4% of their body weight in commercial ration throughout while group B received 2% of their body weight in ration and made up with fresh poultry droppings and feed waste from the broilers housed above them. Group C on the other hand, also received 2% of their body weight in ration, but made up with fresh poultry droppings and feed waste collected from broilers
housed without pigs in pen D. Treatment B and C were specifically designed to ascertain whether the labor needed for daily collection and transfer of poultry droppings to pigs in a separate pen could be eliminated and to determine the effects of space maximization on the studied parameters. Fresh clean water was offered *ad libitum*. The feeding trial lasted 12 weeks at the end of which the pigs were aged approximately 22 weeks and had body weights ranging from 44.37 to 58.70kg. They were also certified clinically healthy.

*Blood collection and analysis*

The animals were slaughtered at the end of the feeding trial. During their slaughter, 5ml of blood sample from each pig was discarded into Ethylene Di-amine Tetra Acetic acid (EDTA) treated Bijou bottles for hematological assay. Blood samples were analyzed within 3 hours of their collection for total erythrocyte and leukocyte counts, haematocrit (PCV), hemoglobin concentration (HBC) and differential leukocyte count according to the methods described by Hemening\(^\text{13}\). Erythrocyte count (RBC) was

<table>
<thead>
<tr>
<th>Parameters</th>
<th>TRTA</th>
<th>TRTB</th>
<th>TRTC</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCV (%)</td>
<td>27.00(^a)</td>
<td>33.50(^b)</td>
<td>31.50(^{ab})</td>
<td>1.92</td>
</tr>
<tr>
<td>HBC (g/dl)</td>
<td>9.55(^a)</td>
<td>11.90(^b)</td>
<td>11.20(^b)</td>
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<tr>
<td>RBC (x106/ul)</td>
<td>7.00(^a)</td>
<td>7.00(^a)</td>
<td>8.00(^a)</td>
<td>3.18</td>
</tr>
<tr>
<td>WBC (x103/ul)</td>
<td>10.40(^{ab})</td>
<td>11.85(^b)</td>
<td>9.55(^a)</td>
<td>0.71</td>
</tr>
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<td>Neutrophil (%)</td>
<td>50.50(^a)</td>
<td>41.00(^b)</td>
<td>52.00(^a)</td>
<td>3.45</td>
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<tr>
<td>Lymphocyte(%)</td>
<td>53.00(^a)</td>
<td>54.50(^a)</td>
<td>50.50(^a)</td>
<td>1.17</td>
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<tr>
<td>Monocyte (%)</td>
<td>0.00</td>
<td>1.00(^a)</td>
<td>0.50(^b)</td>
<td>0.25</td>
</tr>
<tr>
<td>Eosinophil (%)</td>
<td>1.00(^a)</td>
<td>3.00(^b)</td>
<td>1.50(^a)</td>
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</tr>
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<td>0.05</td>
<td>0.05</td>
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<tr>
<td>MCV (fl)</td>
<td>38.57(^a)</td>
<td>47.86(^b)</td>
<td>39.38(^{ab})</td>
<td>2.91</td>
</tr>
<tr>
<td>MCH (pg)</td>
<td>13.64(^a)</td>
<td>17.00(^b)</td>
<td>14.00(^{ab})</td>
<td>1.07</td>
</tr>
<tr>
<td>MCHC (%)</td>
<td>35.37(^a)</td>
<td>35.53(^{ab})</td>
<td>35.56(^b)</td>
<td>0.06</td>
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</tbody>
</table>

\(^{ab}\) means within a row with different superscripts are significantly different (P<0.05).
Table 2: Parasitological evaluation of the stools of pigs raised under integrated broiler/pig production system.

<table>
<thead>
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<th>TRTC</th>
</tr>
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<tbody>
<tr>
<td><em>E. vermicularis</em> ova</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>E. porci</em> ova</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Hookworm ova</td>
<td>-</td>
<td>+++</td>
<td>-</td>
</tr>
<tr>
<td><em>Taenia</em> spp. ova</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Yeast cells</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

+ = Moderately present.  +++ = Highly present.  - = Absent

Table 3: Carcass weights, weights of internal organs and back fat thickness of pigs raised under integrated broiler/pig production system.

<table>
<thead>
<tr>
<th>Parameters</th>
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<th>TRTB</th>
<th>TRTC</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dressed weight (kg)</td>
<td>38.65&lt;sup&gt;a&lt;/sup&gt;</td>
<td>30.40&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>27.70&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.30</td>
</tr>
<tr>
<td>Dressed percentage (%)</td>
<td>61.80&lt;sup&gt;a&lt;/sup&gt;</td>
<td>59.00&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>58.30&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.07</td>
</tr>
<tr>
<td>Heart (%)</td>
<td>0.98&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.75&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.54&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.13</td>
</tr>
<tr>
<td>Lungs (%)</td>
<td>1.81&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.64&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>1.26&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.16</td>
</tr>
<tr>
<td>Liver (%)</td>
<td>3.96&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.95&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.25&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.24</td>
</tr>
<tr>
<td>Kidney (%)</td>
<td>0.78&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.72&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.72&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.02</td>
</tr>
<tr>
<td>Spleen (%)</td>
<td>0.39&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.43&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.36&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.02</td>
</tr>
<tr>
<td>Back fat thickness (cm)</td>
<td>1.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.90&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.06</td>
</tr>
</tbody>
</table>

<sup>a</sup> means within a row with different superscripts are significantly different (P<0.05).

done in a hemocytometer chamber. Total leukocyte count (WBC) was obtained using a hematocytometer with Natt and Henrick's diluent to obtain a 1:200 blood dilution. The number of leukocytes was thereafter estimated as total WBC/μl=number of cells to total WBCx200. PCV was measured by the microhematocrit method with 75x16mm capillary tubes filled with blood and centrifuged at 3000rpm / 5min. Differential count of leukocytes was made from blood smears stained with Wright's dye and each type of cell was counted with a laboratory counter. HBC was also measured by the cyanmethemoglobin method. Various red cell indices such mean corpuscular hemoglobin (MCH), mean corpuscular volume (MCV) and mean corpus-
cular hemoglobin concentration (MCHC) were computed from RBC, HBC and PCV values.\textsuperscript{13}

**Gastro-intestinal parasite evaluation**

At the time of slaughter, fecal samples were also taken directly from the rectum of each test animal. These were transported to the laboratory in properly labelled polyethylene bags within 3 hours of their collection. Using Sheather's solution, a portion of each sample was floated to detect coccidial oocysts. The different coccidial species were identified according to standard laboratory.\textsuperscript{14} For helminth ova, floatation was done with saturated sodium chloride solution and sedimentation method.\textsuperscript{15} The parasites were identified based at the Department of Biological Sciences, Imo State University Owerri. Yeast cells were observed on standard wet preparation before further culture on Sabouraud’s dextrose agar and identification.\textsuperscript{16}

**Internal organ evaluation**

The pigs were weighed, slaughtered and allowed to bleed thoroughly adopting methods described in earlier reports.\textsuperscript{17} Thereafter, the carcasses were cleaned, dissected and eviscerated. The heart, lungs, liver, kidney and spleen were removed and weighed after inspecting them for gross changes. The weights of the different internal organs were further expressed as percentages of the dressed weights of the animals.

**Data analysis**

Data collected were subjected to analysis of variance (ANOVA).\textsuperscript{18} Where significant treatment effect was detected, means were separated using Least Significant Difference (LSD).\textsuperscript{10}

**Results**

**Hematological analysis**

Data on hematological analysis are presented in Table 1. Treatments did not have any significant effect (P>0.05) on the RBC counts. PCV and HBC values were, however, significantly higher (P<0.05) in the two groups receiving poultry waste. The TRTB group had significantly higher total WBC, lymphocytes and monocytes eosinophil values. Neutrophil numbers on the other hand, was significantly higher (P<0.05) in the TRTC group. There was also a significant effect on the erythrocyte indices, MCV, MCH and MCHC. TRTA values of these parameters were significantly different from figures obtained for the other groups. Specifically, MCV and MCH values of the TRTB group were significantly higher (P<0.05) than the control group values, while for MCHC, the TRTC group recorded significantly higher (P<0.05) value than the control.

**Gastro-intestinal parasite evaluation**

Data on parasitological analysis of stools of the experimental pigs are presented in Table 2. A limited number of *Eimeria vermicularis* ova were observed in the stools of the control group. Stools from the pigs receiving poultry waste on the other hand, yielded ova of unidentified hookworm spp., *Eimeria porci* and *Taenia* spp.

**Internal organ evaluation**

Postmortem examination of internal organs of the test animals did not reveal any visible gross lesions at slaughter. Dressed weights and weights of the inter-
nal organs of the treatment pigs are shown in Table 3. The control group recorded the highest dressed weight. The 58.30% obtained from the TRTC group differed significantly (P<0.05) from the values recorded for the control. While the values for hearts and lungs followed the pattern exhibited by the dressed weights, treatments did not have any significant effect on the weights of the livers and the kidneys. Again TRTB group also had significantly (P<0.05) different figures for spleen weight and back fat. The highest back fat value was obtained from the control pigs receiving commercial ration.

**Discussion**

Hematological constituents usually reflect the physiological responsiveness of the animal to its external and internal environments and thus serve as a veritable tool for monitoring animal health\(^{20}\). The present results of hematological parameters are indications that none of the treatments had serious deleterious effect on the internal physiology of the pigs. However, most of the values reported here for the control and the other treatment groups especially the 27.00 to 33.50% PCV and 9.55 to 11.90g/dl HBC are lower than the 41% and 13g/dl respectively reported in literature for pigs raised under temperate environment\(^{21, 22}\). Strong differences are reported between hematological characteristics of breeds of livestock from different geographical and agricultural zones of the world\(^{21, 23}\). These differences have been attributed to nutritional status, breed differences, age of the animal, environmental factors and management systems among others\(^{24, 25, 26}\).

The group housed with broiler birds (TRTB) recorded highest values for total white blood cells (WBC), lymphocytes, monocytes and eosinophils. Exceptional increases in the number of these cells are important diagnostic tools for infectious diseases. For example, induction of eosinophilia is a common phenomenon in cases of helminth infections associated with tissue invasion\(^{27}\). Thus, the significantly higher eosinophil count of the TRTB group in the present study, with a corresponding high incidence of hookworm ova in the stool of the same group, clearly supports this. The hookworm infection however is sub-clinical and did not seem to have adversely affected the performance of the animals in this group as evidenced by higher PCV, HBC and dressed percentage values.

*Eimeria* and helminth parasites were the common intestinal parasites identified in the stools of the trial pigs. This tends to suggest that these are the major intestinal parasitic problems of pigs raised under this type of production system in the humid tropical zone of southeastern Nigeria. It is therefore important to develop an accompanying control program for such diseases as a component of successful field trials of this production system.

Again, the significantly higher total WBC count, lymphocyte, and monocyte numbers coupled with similar trends across the red cell indices (MVC and MCH) among the TRTB group of pigs, may be reflecting some clinically occult events in the animals. Such events were, however, not harmful enough to negatively influence the physiology and growth performance of the pigs as shown by their carcass characteristics. Microbiological evaluation of pigs raised under the integrated broiler/pig production
system is needed to properly elucidate these occult events.

At slaughter, no visible gross lesions were observed on any of the internal organs examined. There was also no significant difference in the figures recorded for both the liver and kidney harvested from the different groups indicating probably that the animals receiving poultry wastes were able to handle the relatively higher uric acid content of such feed. The higher weight of the spleen harvested from the TRTB group agrees with earlier observations. The fact that the groups receiving poultry waste recorded lower back fat thickness tends to suggest that minimal back fat might be one of the high points of the broiler/pig production system reported here.

Although the various data recorded in TRTB and TRTC varied in some cases especially in their WBC counts; these differences did not influence significantly the physiology and growth performance of pigs from the two groups as shown by their carcass characteristics. This indicates that any of these methods could be safely utilized. Adopting the technique of raising broilers above growing pigs in the same pen however, may be more economical especially in the limited backyard space available to poor urban dwellers. This technique also eliminates the extra labor needed for the transfer of droppings.

Conclusion

The relatively superior data obtained from the control pigs tended to suggest that poultry waste from broilers were not perfect substitutes for the commercial feeds used in the trial. However, the carcass quality of the pigs that consumed poultry waste appeared better as their back fat thickness was smaller, a trait much cherished by consumers. The technique that allows the raising of broilers above growing pigs in the same pen may be more feasible especially in the limited backyard space available to poor urban dwellers. *Helminthes* and *Eimeria* control programs should form part of the development strategy for an integrated broiler/pig production system in the humid tropical zone of southeastern Nigeria.

References


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OBSERVATION ON MORTALITY OF SHEEP FED ACACIA ANGUISTISSIMA AS A SUPPLEMENT

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²National Veterinary Institute, P.O.Box: 19, Debre Zeit, Ethiopia

OBSERVATION SUR LA MORTALITE DES MOUTONS NOURRIS D'ACACIA ANGUISTISSIMA COMME COMPLEMENT ALIMENTAIRE

Résumé

Deux expériences ont été faites à l'Institut international de recherche sur l'élevage (ILRI) à Debre Zeit en Ethiopie sur les moutons nourris d'Acacia angustissima comme complément alimentaire en décembre 1996 et mars 1999. Au total, 13 animaux étaient utilisés pour entreprendre l'étude. Tous les moutons nourris de complément d'Acacia angustissima sont morts au cours de l'expérience. Les conclusions cliniques et les résultats de l'examen macroscopique et histopathologique ont été enregistrés. Quelques recommandations sur l'utilisation de A. angustissima comme complément alimentaire des ruminants ont été formulées.

Mots-clés: Acacia angustissima, aliment, mortalité, mouton.

Summary

Two experiments were conducted at the International Livestock Research Institute (ILRI), Debre Zeit-Ethiopia, on sheep fed Acacia angustissima (A. angustissima) as a supplement in December 1996 and March 1999. A total of 13 animals were used for the study. All sheep that were fed the supplement-Acacia angustissima died during the experiment. The clinical findings, gross and histopathological examination results were recorded. Some recommendations concerning the use of A. angustissima as ruminant feed supplement have been made.

Key words: Acacia angustissima, Feed, Mortality, Sheep

Introduction

A series of investigations were carried out at the ILRI-Debre Zeit sub-station in Ethiopia to identify leaves and pods of different plants and trees as a sustainable resource for animal feed in particular as a ruminant protein supplement. Of the various plants and trees used, Acacia species have attracted major attention since these species are containing with high protein and other natural resource benefits¹,²,³,⁴. However, Acacia species are known for their unsubstantiated toxicity problems⁵,⁶,⁷,⁸. A member of Acacia species, Acacia angustissima, was used as a feed supplement for sheep in two different experiments. The objectives of this paper were, there-

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fore, to describe the clinical episodes, gross and histopathological findings of those sheep that died of Acacia toxicity and to give some general recommendations.

Materials and methods

Experiment Number One

The first experiment was conducted from December 11-27, 1996 on eight male sheep with about similar age, weight, body condition and management. These sheep were divided into two groups as: experimental (five) and control (three) groups. The experimental sheep were numbered as R4664, R4660, M3815, H62, and H17, and fed A. angustissima at a rate of 250 gms/day/head together with 1420, 1310, 1295, 1275, and 1225 grams of teff (Eragrostis tef) straw/day/head, respectively. The control sheep were not fed the supplement.

Experiment Number Two

The second experiment was started on March 10, 1999 on five sheep with similar age, weight, body condition and management. These sheep were also divided into two groups as: experimental groups-three animals and control groups- two animals. The experimental sheep were fed equal amount of 300 grams of Acacia angustissima and 700 grams of maize stover/day/head. Whereas the control sheep were not fed with the supplement-Acacia angustissima.

Clinical observation

Both the experimental and control groups were clinically monitored twice per day for any symptoms of illness.

Histopathology Examination

Tissue sections were prepared from the affected organs including the abomasum, liver, kidneys, lungs, heart muscle and brain then processed as indicated earlier.

Results

Clinical Findings

The clinical episodes observed in all experimental sheep that died were generally similar. The sheep had anorexia, laboured breathing, and pulse rate ranging from 20 to 25/minute, temperature between 35 to 38°C, rumen motility was between 2-3/minute and profuse salivation at the onset and then decreased at the latter stage of the disease. In all the cases, nervous syndromes were prominent and consistent including pressing of the head against any hard object, putting the head down, depression, grinding of the teeth, twitching and jerking of the body and convulsions.

Mortality

Experiment One. The five sheep that were fed with Acacia angustissima died within two weeks of the experimental period. However, the control group remained apparently healthy.

Experiment Two. Those animals (three) that were fed with Acacia angustissima died within a week, whereas the controls remained apparently healthy.

Hematological Features

Hematological examinations revealed a packed cell volume (PCV) of 36-38%, a Red Blood Cell count of 11 x 106 - 12 x 106 and a Hemoglobin level of 10 -11.9 gms/deciliter.

Gross Pathological Lesions

Although the severity of the reaction varied from sheep to sheep, the following
were the major lesions encountered. Upon opening of the abdominal cavity, 200–300 ml of straw colored fluid was collected which coagulated immediately. The contents of the abomasum were blood tinged and the abomasal wall was congested. The liver looked mottled in appearance and enlarged with bulged edges. The kidneys appeared congested and mottled; the cut surfaces revealed excess blood stained fluid. Inside the thoracic cavity, 150-250 ml (varied from case to case) of straw colored fluid was collected. In some of the cases, the fluid was blood tinged. The lungs were edematous, congested and heavy. Blood stained fluid oozed out from cut surfaces of the lungs. In few of the cases ecchymotic hemorrhages were observed on the surfaces of the lungs. The trachea and the bronchi were filled with froth. The pericardial sac was filled with excessive amount of straw colored fluid. In some of the cases ecchymotic hemorrhages were also observed in the epicardium and the pericardium. No gross lesions were seen in the brain but it appeared wet and a bit enlarged.

**Histopathological Findings**

Histopathological examination of the abomasal tissue showed focal superficial desquamation of the epithelium, pronounced hyperemia, hemorrhages and edema throughout the mucosa and submucosa of the abomasum. The livers showed moderate cell swelling including loss of cellular outline, nuclear changes and vacuolation. The kidney showed pronounced tubular degeneration with hyaline casts and strongly expressed edema and hemorrhages in the tubules as well as in the interstitia. The lungs had severe congestion and hemorrhages in the alveoli and interstitia, fibrous exudates and limited areas of emphysema. The heart muscles showed an early form of Zenker’s degeneration. The brain sections revealed severe perivascular edema.

**Discussion**

The International Livestock Research Institute (ILRI) has identified a range of anti nutritional factors and toxins in multipurpose trees and shrubs (Acacia spp are the major ones). These toxins can act either on the rumen microbes or on the host animal itself leading to death\(^1\)\(^,\)\(^7\)\(^,\)\(^8\). Although data are not available on the phytotoxicity of the plant (*A. angustissima*) used, this experiment revealed that this particular plant damages the parenchymatous organs, notably the liver, kidneys and the lung. Circulatory disturbances were also observed including pronounced edema in the lungs, kidney, brain and excess accumulation of fluid in the abdominal and thoracic cavities of those affected sheep. A very high content of proanthocyanidins in *A. angustissima* made similar observations that most sheep died after consuming *A. angustissima* supplemented feed\(^9\).

The remarks made earlier\(^1\) comply with the annotation of the present investigation where most of the experimental animals died due to the toxicity of the *A. angustissima* supplemented feeding regime.

The histopathological findings of this investigation are highly suggestive of the extensive toxicity in various tissues. The histological lesions observed in liver were similar to those indicated by\(^1\)\(^1\). The Zenker's degeneration encountered in the heart muscle was similar to the observation done by\(^7\)\(^,\)\(^8\)\(^,\)\(^10\)\(^,\)\(^11\).
References


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SHORT COMMUNICATION

CONTAGIOUS BOVINE PLEUROPNEUMONIA AND LUNG CONDEMNATION IN SOKOTO METROPOLITAN ABATTOIR IN NIGERIA

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Contagious Bovine Pleuropneumonia (CBPP) is a contagious disease affecting the lungs and pleura of cattle and other closely related ruminants and is caused by an infective organism called *Mycoplasma mycoides*. In Africa, the disease remains one of the principal causes of poor performance of the livestock sub-sector and the gap between supply and demand of meat and milk in the continent. The disease had plagued cattle in Europe and elsewhere during the 19th Century as well as in the early decades of the 20th Century. The disease has been eradicated in many parts of the world.

CBPP is a devastating and endemic disease of cattle in most parts of Africa. Today, the disease is widespread in Africa and its incidence is increasing in Nigeria. In Nigeria, the disease occurs mainly in the Northern parts of the country. The country was divided into zones based on the occurrence of the disease. The zones are (a) the exposed zone comprising Kaduna, Kano, Jigawa, Benue, Kogi, Plateau States and Lafiagi in Borgu District of former Kwara State, (b) the enzootic zone made up of Borno, Yobe, Bauchi, Sokoto, Kebbi, Adamawa and Taraba States, (c) The free zone which is the rest of the country. Recently, the Nigerian Animal Disease Information System (NADIS) under the auspices of Pan African Control of Epizootics (PACE) classified Nigeria as an endangered zone based on her CBPP status. The study was conducted to determine the occurrence and propose suggestions on how to prevent and control the disease or at least reduce the occurrence to an insignificant proportion.

The study was conducted in Sokoto town. The town is in Sokoto State, which is one of 36 states in Nigeria. The town is located at the northwestern part of Nigeria and shares international border with Niger Republic to the north. The total and mean annual rainfall are 707mm and 59mm respectively. The available records on 162,111 adult zebu cattle slaughtered from 1990-1994 at the Sokoto metropolitan abattoir were used in this study. This breed of cattle is found in northwestern Nigerian and in Cameroon in a climatic environment that is tropical and semi-arid. The diagnosis of CBPP-affected lungs made by veterinarians attached to the metropolitan abattoir was arrived at based on the pathological manifestations of the disease on the pleura, the left lung and especially the middle lobe being particularly affected.

Other conditions observed and which necessitated condemnation included tuberculosis (TB) and hydatid cyst. There was no attempt made to find out the relationship of the disease to sex. The estimate
of the revenue lost was based on the price of the lungs in the local market. The dollar ($) equivalent was calculated based on the prevailing exchange rate during the time of the study. In 1990, 1991, 1992, 1993 and 1994, the exchange rates were N10.00, N15.00, N20.00, N40.00 and N60.00 to a dollar respectively. Yearly slaughter/presentation figures, cases encountered /condemned and revenue loss were tabulated. Out of the total of 162,111 lungs presented for examination during the period under study, 3,338 (2.1%) lungs were condemned as a result of CBPP. Table 1 shows the summary of slaughter figures, case encountered and condemned during routine meat inspection and revenue losses for the period studied. Other conditions that necessitated condemnations apart from CBPP included tuberculosis (TB) and hydatid cysts (Table 2).

From the results of the study, it could be observed that condemnation of lungs due to CBPP occurs regularly. The reason

<table>
<thead>
<tr>
<th>Year</th>
<th>No slaughtered/ Presented</th>
<th>No of CBPP cases (%)</th>
<th>Losses ($N)</th>
<th>Losses ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>30,329.00</td>
<td>587(2.0)</td>
<td>29,350.00</td>
<td>2,935.00</td>
</tr>
<tr>
<td>1991</td>
<td>31,654.00</td>
<td>583(1.8)</td>
<td>34,980.00</td>
<td>2,332.00</td>
</tr>
<tr>
<td>1992</td>
<td>32,654.00</td>
<td>718(2.2)</td>
<td>50,260.00</td>
<td>2,513.00</td>
</tr>
<tr>
<td>1993</td>
<td>33,333.00</td>
<td>731(2.2)</td>
<td>58,480.00</td>
<td>1,462.00</td>
</tr>
<tr>
<td>1994</td>
<td>34,064.00</td>
<td>719(2.1)</td>
<td>64,710.00</td>
<td>1,079.00</td>
</tr>
<tr>
<td>TOTAL</td>
<td>162,111</td>
<td>3,338(2.1)</td>
<td>237,780.00</td>
<td>10,321.00</td>
</tr>
</tbody>
</table>

Table 2: Summary of slaughter figures and cases of other conditions of the lung encountered and percentage and revenue loss for the period studied 1990-1994.

<table>
<thead>
<tr>
<th>Year</th>
<th>No slaughtered/ Presented</th>
<th>cases of TB(%)</th>
<th>No. of cases Hydatid(%)</th>
<th>Losses ($N)</th>
<th>Losses ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>30,329.00</td>
<td>30(0.1)</td>
<td>25(0.1)</td>
<td>2,750.00</td>
<td>275.00</td>
</tr>
<tr>
<td>1991</td>
<td>31,654.00</td>
<td>33(0.1)</td>
<td>20(0.1)</td>
<td>3,180.00</td>
<td>212.00</td>
</tr>
<tr>
<td>1992</td>
<td>32,654.00</td>
<td>40(0.1)</td>
<td>35(0.1)</td>
<td>5,040.00</td>
<td>252.00</td>
</tr>
<tr>
<td>1993</td>
<td>33,333.00</td>
<td>40(0.1)</td>
<td>31(0.1)</td>
<td>5,680.00</td>
<td>142</td>
</tr>
<tr>
<td>1994</td>
<td>34,064.00</td>
<td>45(0.1)</td>
<td>35(0.1)</td>
<td>6,750.00</td>
<td>113</td>
</tr>
<tr>
<td>TOTAL</td>
<td>162,111</td>
<td>188(0.5)</td>
<td>146(0.5)</td>
<td>23,400.00</td>
<td>994.00</td>
</tr>
</tbody>
</table>
for this could be that Sokoto falls within the enzootic zone of the disease\textsuperscript{11} and Nigeria having been classified as an endangered zone based on her CBPP status. The observation in this study on the occurrence of tuberculosis and hydatid cyst is similar to what had been documented\textsuperscript{12, 13}.

The continued occurrence of CBPP in this area could be due to, factors such as reduced funding for vaccination, possibly associated with the cessation of externally funded vaccination campaigns against rinderpest, earlier carried out in conjunction with vaccination against rinderpest\textsuperscript{14}. Other factors include changes in vaccines and vaccine usage, cost recovery for CBPP and reduced disease surveillance\textsuperscript{2}.

In enzootic zones, in which Sokoto falls, PACE put forward the following control measures. These include annual mass vaccinations of cattle against the disease for five years and evaluation, improvement of cattle movements control, strengthening of the epidemiological networks and improvement of epidemiological and economic knowledge of the disease. In free zones where sporadic outbreaks occur, quarantine, testing, slaughter and vaccination should be used. In exposed areas prone to more frequent sporadic outbreaks, control and prevention should be either by vaccination or complement fixation test and slaughter. These control measures are necessary in these free and exposed areas to prevent the spread of the disease to enzootic zones where it could cause considerable loss of cattle. Considering the fact that Sokoto, a state in Nigeria known for cattle production falls within the enzootic zone of the disease, efforts should be made to safeguard the cattle herd in this area.

This becomes more imperative against the background that the protein intake by Nigerians is far below the minimum animal protein requirement\textsuperscript{15}.

Based on the experience gained in the successful control of the disease in Nigeria from 1973 to 1974, it was emphasized that prevention of reinfection was most important and required strict control of movement of trade cattle. This singular and most important factor and other factors of the spread of the disease could have been neglected leading to the reappearance of the disease in the country. For instance, due to the porous border between Nigeria and Niger Republic, control of movement of trade cattle is often a difficult task.

**Conclusion**

To achieve CBPP control, there should be strict adherence to control of movement of trade cattle across borders. Veterinarians need to be posted to these borders armed with diagnostic equipment to examine the trade cattle. Those found to be reactors should be quarantined and treated while those that are clinically ill should be sent to the nearest abattoir for slaughter and compensation paid to the owners.

Stockowners should be encouraged to report any sign of the disease in their herd by paying them adequate compensation.

There should be surveillance mounted against the disease by occasionally visiting randomly selected herds where tests should be conducted to know whether some animals are suffering from the disease or harbouring the causative agent.
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SHORT COMMUNICATION

CROSS-PROTECTION STUDY OF FOUR INFECTIOUS BURSAL DISEASE VIRUS FIELD ISOLATES AND ONE VACCINE STRAIN (D78) IN SUSCEPTIBLE CHICKENS

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Infectious bursal disease (IBD) is a disease of young chickens caused by infectious bursal disease virus (IBDV), a member of the Birnaviridae family. Signs of the disease as described by Cosgroue¹ included soiled vent feathers, whitish watery diarrhea, ruffled feathers, anorexia, depression, dehydration and death. The incubation period is very short with clinical signs seen in 2-3 days post exposure².

In the Sudan, the disease which was first reported in 1980³ caused continuous outbreaks throughout the country. Because of vaccination breakdowns in the field and the occurrence of the disease outbreaks among vaccinated flocks, this study was meant to evaluate the local strains of IBDV.

5-6 weeks old chickens were obtained at day-old from commercial source. They were tested for the presence of IBD antibodies by the agar-gel precipitation test (AGPT). Sero-positives were excluded.

Four local IBD viruses were collected from natural outbreaks of IBD which involved previously vaccinated chickens. These isolates designated Butri, Gezira, Omdurman and Arab Company (Arab Co.) were propagated in chick-embryos and titrated in susceptible cockerels. Their chicken ID50 (ch ID50) was recorded as $10^{7.5}$, $10^{7.1}$, $10^{5.5}$ and $10^{5.5}$/ml for the four viruses respectively.

D78 vaccine strain from Intervet was titrated in chick-embryo fibroblast cell culture with TCID₅₀ of 107.1 and used as control.

Birds in the five groups were infected with $10^3$ chID₅₀/dose of one of the four IBD field and $10^3$ TCID₅₀/dose of the D78 vaccine strain virus. A sixth group of chickens was reserved as uninfected control. Two weeks later, each group of birds was divided into five subgroups each of which was challenged with $10^6$ chID₅₀/dose of one of the four field viruses and $10^6$ TCID₅₀/dose of D78 vaccine strain.

Cross-protection against challenge was evaluated during an observation period of three days after challenge by recording reduction in morbidity, mortality rate and post mortem lesions in challenged and control birds.

Results showed that the three field isolates Butri, Gezira and Arab Co. were almost similar in their pathogenicity to chickens while Omdurman isolate was less pathogenic. Cross-protection against bursal damage was variable but comparable.
Protection was less in the group infected with D78 vaccine strain and least among the control group.

From the results, it could be seen that Omdurman virus isolated in January 1993 was the least pathogenic of the four investigated field isolates. The other three viruses were isolated after 1995. The number of dead chickens following challenge of controls with Butri, Omdurman, Gezira and Arab Co. isolates were 5/10, 4/10, 6/10 and 6/10 respectively, no mortality was recorded after D78 strain challenge either in the infected or control groups. The total mortality rate due to Omdurman virus challenge was least (9/60) compared to that due to challenge with other three field viruses (15/60, 16/60 and 14/60 respectively).

As Omdurman virus was isolated earlier it is likely that it belonged to the moderate pathotype prevalent prior to 1994 when the first cases of the highly virulent strains of IBDV were first reported in Sudan.

D78 as a vaccine strain gave some protection against field virus challenge. However, with the emergence of the highly virulent IBD virus in the Sudan as part of the worldwide dramatic change in the epizootiology of the disease due to the appearance of this type of virus, it seems necessary to use a more invasive vaccine strain with more residual pathogenicity such as 228 E hot IBDV vaccine from Intervet. It was reported that intermediate vaccines are more antigenically related to pathogenic types than to the mild ones and are more protective to specific pathogen free (SPF) chickens against challenge. However, the role of genetic and individual variation in response to challenge should also be considered.

The immune response induced by infection with the four field isolates of IBDV

**Table 1**: Bursal damage and mortality rates in infected and cross-challenged chickens using four field and one vaccine strain of IBDVs

<table>
<thead>
<tr>
<th>Challenge virus</th>
<th>Infection viruses</th>
<th>Total No. of deaths (out of 60)</th>
<th>Control</th>
<th>Omdurman</th>
<th>Arab Co.</th>
<th>Gezira</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butri</td>
<td>BD MR</td>
<td></td>
<td>BD MR</td>
<td>BD MR</td>
<td>BD MR</td>
<td>BD MR</td>
</tr>
<tr>
<td></td>
<td>Butri</td>
<td>3/5</td>
<td>0</td>
<td>3/5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Omdurman</td>
<td>1/5</td>
<td>0</td>
<td>1/5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Gezira</td>
<td>4/5</td>
<td>3/5</td>
<td>3/5</td>
<td>3/5</td>
<td>3/5</td>
</tr>
<tr>
<td></td>
<td>Arab Co.</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>D78</td>
<td>2/5</td>
<td>2/5</td>
<td>2/5</td>
<td>2/5</td>
<td>2/5</td>
</tr>
</tbody>
</table>

BD = Bursal Damage
MR = Mortality Rate
and the D78 vaccine strain was cross-protective against cross-challenge by the five viruses suggesting close antigenic relationship.

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References


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RECOMMANDATIONS AUX AUTEURS

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.

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


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

Genres d'articles publiés dans le Bulletin
- des communications originales.
- des brèves communications.
- analyse des articles proposés 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 résumé ne doit pas dépasser 200 mots. Son texte bref et concis comprendra les principaux résultats et la (les) conclusion(s) de l'étude.

L'introduction expose le but de la recherche.
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 se fera à l'aide de numéros (entre parenthèses) et non pas par les noms des auteurs.
La bibliographie doit respecter la présentation suivante:

1. Journal
Le nom de l'auteur (ou des auteurs) suivi des initiales du ou des prénoms, l'année de parution (entre parenthèses), l'abréviation du titre du périodique suivant la "World List of Scientific Periodicals" (soulignée), le numéro de la première page. Le titre de l'article ne doit pas être inclus.

2. Revue
Le nom de l'auteur (ou des auteurs) suivi des initiales du ou des prénoms, l'année de parution (entre parenthèses), le titre exact (souligné), la ville où elle a été publiée, les éditeurs, le numéro de la première page.

3. Rapport annuel
Le nom du pays, l'année faisant l'objet du rapport, puis le nom du service ou de l'organisation, le numéro de la première page.
Si le même auteur est cité plus d'une fois, ses publications seront indiquées dans l'ordre chronologique dans la liste bibliographique et s'il y a plus d'une publication, les lettres "a,b,c," seront ajoutées aussi bien dans la liste bibliographique que dans le texte.

Illustrations
Les tableaux et les titres doivent être en nombre aussi réduit que possible. Un tableau d'une trop grande dimension est difficile à lire même s'il peut être reproduit. Les tableaux et les figures doivent être numérotés dans l'ordre, respectivement Tableau 1, etc., ou Fig. 1 etc. et joints à la fin du texte. Les références aux tableaux et aux figures dans le texte doivent être numérotées et non pas indiquées "tableau ci-dessous" ou figure ci-dessous". Les illustrations en couleurs ne sont reproduites qu'aux frais de l'auteur (ou des auteurs).

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Une brève communication signifie que l'article ne peut pas être publié comme une communication normale. Elle ne doit pas dépasser deux pages imprimées ou 1000 mots en incluant deux illustrations au maximum. Elle doit donc respecter les mêmes normes qu'un article habituel, sauf que le résumé et les sous-titres ne sont pas nécessaires.

Épreuves typographiques
Les épreuves typographiques sont envoyées à l'auteur qui en effectue la correction des coquilles et en assure le retour rapide (dans les 3 jours).

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25 tirés à part de chaque article sont fournis gratuitement. Il est possible de commander des tirés à part supplémentaires et les payer au moment des épreuves typographiques. Le coût d'un tiré à part supplémentaire s'élève à 2 SEU.

Abonnements
Le coût de l'abonnement annuel y compris le tarif d'affranchissement (par voie terrestre) et le frais de manutention, est de 50 SEU. L'envoi par avion est possible sur simple demande.

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Il est également possible de se procurer, sur simple demande, les anciens numéros aux mêmes prix.