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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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Introduction stating the purpose of the work.
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Results regular.
Discussion regular.
Acknowledgements.
References numbered consecutively in the order they are first mentioned in the text. Identification of references in the text should be by numbers (in parentheses) and not by authors’ names. References should take the following form:

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2. The Impact of Climate Change on Coastal Ecosystems

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OCCURRENCE AND SPATIAL DISTRIBUTION OF CLINICAL MASTITIS IN SMALLHOLDER DAIRY FARMS IN TANGA, TANZANIA.

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INCIDENCE ET REPARTITION SPATIALE DE LA MAMMITE CLINIQUE DANS LES PETITES FERMES LAITIERES A TANGA EN TANZANIE

Résumé

Une étude rétrospective transversale entreprise récemment à Tanga en Tanzanie a montré que la mammite est une infection fréquente dans les petites fermes laitières. En 1998, la mammite clinique a sévi avec un taux de prévalence de 10% chez 308 vaches sensibles dans certaines fermes de la région de Tanga. Environ 40% des personnes interrogées dans les fermes ont affirmé, en tant qu’élèveur de bétail laitier, avoir eu connaissance de la mammite. La perte en argent due à un quartier affecté par la maladie et non-productif en permanence pour une vache qui produit neuf litres/jour, sur la base de 31 vaches affectées en 1998, était évaluée à 8.160 $ EU. Le traitement de cas bénin de mammite pour les mêmes vaches coûtait environ 1.733 $ EU. La mammite constitue également un obstacle important à l’industrie de transformation du lait puisqu’elle réduit la qualité et la durée de conservation avant vente du lait cru et du lait transformé. Il faudrait donc considérer la mammite comme une maladie importante et élaborer un programme de lutte afin d’améliorer la qualité et la production laitière.

Mots-clés : petite exploitation, mammite, prévalence, Tanga, sensibilisation, prévention

Summary

A restrospective cross-sectional study survey carried out recently in Tanga, Tanzania, showed that mastitis was a common and widespread infection in the smallholder dairy sector. In 1998, clinical mastitis occurred at a prevalence of 10% in 308 susceptible cows in selected farms in Tanga regions. An estimated 40% of the respondents from surveyed farms claimed to have seen clinical mastitis during their dairying life time. Quantitative lactation monetary loss due to permanently lost quarter for a cow producing nine litres per day, based on 31 affected cows in 1998 was estimated to be US$ 8160. Treatment of mild case of mastitis for the same period was estimated at US$ 1733. Mastitis is also an important constraint to the milk processing industry as it reduces quality and shelf life of raw and processed milk. There is therefore a need to consider mastitis as an important disease and devise control programme so as to improve milk yield and quality.

(Key words: Smallholder, mastitis, prevalence, Tanga, awareness, prevention)
Introduction

Dairy production is a rapidly expanding sector in many urban and rural parts of Tanzania. The estimated annual growth rate is 6% and agriculture is thought to contribute 50% of the Gross Domestic Product (GDP) of which the livestock sub sector contribute 20%. Out of this 20%, beef contributes 40%, milk 30%, while other products of livestock contribute 30%.

A number of factors, including diseases limit further development of the dairy industry. Of the diseases, mastitis, a key production disease is thought to inflict severe damage to the dairy industry than any other single disease. However, it seems that it has not received due priority in any national animal health control schemes. Substantial losses result from reduced milk production and quality, the withholding or discarding of milk, veterinary costs, control measures, and increased replacement costs due to high and premature culling. Milk from infected udder pose public health risk hazards due to potential microbes, antibiotic residues or zoonotic agents if milk is coming from tuberculosis and brucellosis affected cows.

Available studies on clinical/subclinical mastitis in Tanzania are only confined to some regions or large scale farms in Morogoro, Arusha, Mwanza Mbeya Kilimanjaro and Dar es Salaam. Information on the disease status in smallholder dairy farms in Tanga remains unknown.

The current study was initiated and conducted with the objective of estimating the prevalence of clinical mastitis in Tanga smallholder farms. The purpose was to identify mastitis infection, explain the spatial distribution and identify possible management factors that might be associated with the disease.

Materials and Methods

The study was conducted on 200 smallholder farms that were randomly selected from a sampling frame of 3001 farms in Tanga Region, north eastern Tanzania (Epi-Info, version 6.04d, CDC, USA). The list of 3001 farms was obtained from the Tanga dairy development programme database.

A survey was conducted in all selected farms using a structured questionnaire between January and April 1999. Data collected were directed at farm and cow level events and management practices of 1998. The grid location of each study farm was recorded to an accuracy of 3 metres using a GPS receiver (Magellan™-System Corporation, California) positioned clear of heavy vegetation and buildings. The latitude and longitude of each farm were then logged into Garmin, PC XS version 2.09 software (Garmin Corp., Olathe Kansas, USA).

Farms, individual cows and Geo reference derived data were entered into a separate data base (Epi-Info and Garmin PG soft ware). Simple associations between variables were tested by contingency table using Chi-square. Initial steps comprised of descriptive analysis to verify distribution of various variables.

The proportion of clinical mastitis cows by farm required for plotting proportion circle base maps were calculated in Excel software program (Microsoft Corporation, USA). Idrisi software program was used to plot geo-reference coordinates into base maps.
Results

Response rate

All selected farms were visited and farmers interviewed (100% voluntary response rate). Of the 200 farms, only 185 (92.5%) had lactating animals during 1998. Fifteen farms (7.5%) had no animals due to various reasons including death, leaving dairy or leaving the study area.

Evidence of clinical mastitis

Of the respondents interviewed, 40% (33.9-48.6) were reported to have seen clinical mastitis during their dairying life at the farm and was recognisable by the sign as shown in Fig 1. Of the 308 susceptible cows from surveyed farms, evidence of clinical mastitis was estimated at 10% in 1998 alone. By the time of actual survey, the herd size ranged from 0-13 animals (of all ages and sex, average number of female stock above 2.5 yrs per farm ranged from 1-3). Farm variation of clinical mastitis between district was not statistically significant ($X^2 = 6.09$, df= 4, p = 0.1922).

Of the 31 (10%) out of the 308 susceptible cows reported to have clinical

<table>
<thead>
<tr>
<th>Table 1. Distribution of farm (management) variables - 1998.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
</tr>
<tr>
<td>-------------------------------------------------------------</td>
</tr>
<tr>
<td>a) Calf rearing system (N=200)</td>
</tr>
<tr>
<td>Bucket</td>
</tr>
<tr>
<td>Suckled</td>
</tr>
<tr>
<td>b) Pre &amp; Post milking udder preparation (N=185)</td>
</tr>
<tr>
<td>Wash hand</td>
</tr>
<tr>
<td>Use teat lubricants</td>
</tr>
<tr>
<td>Wash udder (warm / cold water)</td>
</tr>
<tr>
<td>Check udder</td>
</tr>
<tr>
<td>Use cloth</td>
</tr>
<tr>
<td>Use teat dip</td>
</tr>
<tr>
<td>c) Type of lubricants (N = 139)</td>
</tr>
<tr>
<td>Cooking oil</td>
</tr>
<tr>
<td>Petroleum jelly</td>
</tr>
<tr>
<td>Milk salve</td>
</tr>
<tr>
<td>d) Milk technique used (N=179)</td>
</tr>
<tr>
<td>Finger squeezing</td>
</tr>
<tr>
<td>Stripping</td>
</tr>
<tr>
<td>e) Seen udder disease (N=195)</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>f) Share udder cloth (N=54)</td>
</tr>
<tr>
<td>0 - Not sharing</td>
</tr>
<tr>
<td>1 share btn one cow</td>
</tr>
<tr>
<td>2 share two cow</td>
</tr>
<tr>
<td>3 share three cow</td>
</tr>
<tr>
<td>4 share four cow</td>
</tr>
<tr>
<td>g) Dry cow therapy (N=177)</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
</tbody>
</table>
mastitis in 1998, higher proportion of the cases were reported to occur during the first two months post calving (43%) and lactation (45%) respectively (Fig 2). The reported clinical mastitis was not significantly associated with levels of exotic blood -F1, F2 or F3 ($X^2 = 0.73$, df=2, P=0.694).

**Effect of mastitis on milk yield and costs**

Pre- and post-clinical mastitis milk yield trend is shown by box and whisker plot (Fig 3). The ‘box’ represents the central 50% data on milk yield and is further divided in two by the median (the line in the box). The upper and lower boundaries of the ‘box’ represent the upper (75%) and lower (25%) quartiles. The ‘whiskers’ represent the minimum and maximum values of the milk yield. The outlying observations are marked outside the ‘whiskers’. In general, one to two litres of milk are lost daily following encountering and treatment of a mastitis case. Monetary loss due to clinical mastitis per cow was estimated using the following formula\(^5\).

\[
Em = \frac{P \times (L \times Kg \times B)}{M} \times 4
\]

Where: Em = loss due to clinical mastitis,

\[
P = \text{cow’s price}, \quad L = \text{days no milk delivered}, \quad Kg = \text{average daily milk production}, \quad B = \text{price per kg raw milk}, \quad M = \text{number of affected quarters}.
\]

If a cow valued at Tsh. 250,000/= with 300 days of milk, and an average milk production of 9 litres per day at the price Tsh. 2001/=/kg, lost one quarter permanently, the overall loss per lactation would be: Tsh. 197,500/= (US$ 263.3).

Assuming all 31 cows lost one quarter each, cumulative loss of Tsh. 6.12m (US$ 8,160) was conservatively estimated.

\[
Et = M \times [C \times (L \times Kg \times B)] + [d \times Kg \times B \times n'/4] + P
\]

Where: Et = cost of treatment, M = number of quarters affected, C = culture and sensitivity test, Im = Intramamary infusion, ln = systemic injection, D = days of treatment, d = days milk withheld, Kg = normal daily milk production, B = price per kg raw milk, n = no. of quarter(s) milk being withheld, p = miscellaneous expenses.

Therefore a cost of Tsh 41,650/ = (US$ 55.5) or [equiv. to Tsh 1.3, (US$ 1,733.3)] from 31 cows] overall results from a cow producing 9 litres daily, one
quarter affected with a mild form of mastitis, needing three day treatment, milk withheld for seven days from four quarters, costing 5,000/= for bacterial culture and sensitivity cost, 6,000/= for mastitis tube (1,000 x 6; Tsh x milking), Tsh 3500 for systemic injection, Tsh 200/kg raw milk price and Tsh 5,000/= for miscellaneous expense i.e. vet fees, transport (1 US$ = Tsh 750/=).

Discussion

In this study, there was widespread evidence of clinical mastitis occurring in all studied zones. Low evidence of clinical mastitis in Lushoto might probably be due to the general low milk production levels.

**Fig. 2.** Spatial distribution of clinical mastitis parity and month of occurrence in Tanga in 1998.

**Fig. 3.** Box and whisker plot for clinical mastitis in Tanga (based on 31 cows reported to have had clinical mastitis in 1998)
of the cows compared to other zones and the long experience in years of dairy farming in this zone contrary to other zones as dairy farming started way back in the early sixties.

The observed temporal pattern of the disease events, coincides with high peak yield, suggesting most clinical infections to be acquired in this period. Blood et al.,\textsuperscript{16} reported the first two months of lactation to be the most susceptible period. Non-resilient behaviour of cows (first lactating cows), less milking experience (first milkers), poor milking technique (65% stripping as opposed to 35% five finger squeezing), the use of non-conventional teat lubricants (70%) might have probably explained the observed clinical mastitis in smallholder farms.

Despite the fact that most farms adequately practice pre-udder milking preparations, and were aware of mastitis, post milking preparation was poorly carried out. No single farm used teat dip and the use of dry cow therapy (2%) was inadequately practised. Restricted suckling (85%) is thought by many farmers to be a preventive measure against mastitis\textsuperscript{17,18}. The later workers that suckling has a positive mastitis infection reduction.

Results from this study showed that, milk yield from mastitis infected animals dropped to the level that resumption to the original level was not attained. This indicated that the original productivity cannot be restored due to permanent damage of the udder tissue following mastitis. If infection is not contained, such an infected quarter may lose up to 25% of milk production and produce only poor quality milk as long as the infection persists\textsuperscript{15}.

Recall bias was a clear potential problem in a retrospective cross-sectional study of this type- particularly because the analysis relied on the date of clinical events. In some cases, it was not possible to determine the precise timing of events due to absence of accurate written records. However, we felt the process of detailed tracing of all cows provided sufficient information on the timing of events. Furthermore, due to few mastitis cases, few milking cows per farm and limiting the study to the events of 1998 just prior to the start of the study, the recall of major farm events was enhanced.

The study has highlighted mastitis to be a problem and a disease of major economic importance, in milking cows in this area. Mastitis, like other diseases of veterinary importance should receive adequate support in any national animal health control schemes. Farmers should be sensitised on better dairy husbandry methods and hygiene. They should be taught simple and less expensive methods of detecting udder infection like the use of strip cup or any other dark surface to detect changes in milk.

Acknowledgements

This study was funded by the British Government through the Department for International Development (DFID NRRD) Animal Health Research Programme. The participation and cooperation of the smallholder farmers, Tanga Dairy Development Programme staff is highly appreciated. Thanks to Drs. L. Schooman, B. Van Munster and Y. Msanga for proof reading the manuscript. Thanks are extended to the Director of Veterinary Service for permission to publish this work.
References


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THE PREVALENCE AND ECONOMIC IMPACT OF BOVINE FASCIOLIOSIS AT MEKELLE MUNICIPAL ABATTOIR IN TIGRAY REGION, ETHIOPIA

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LA PREVALENCE ET L’IMPACT ECONOMIQUE DE LA DISTOMIASSE BOVINE A L’ABATTOIR MUNICIPAL DE MEKELLE DANS LA REGION DU TIGRE EN ETHIOPIE

Résumé

Une enquête a été menée d’octobre 1994 à février 1995 à l’abattoir municipal de Mekelle dans la région du Tigré dans le nord de l’Ethiopie. Elle a été réalisée en vue de déterminer la prévalence de la distomiasse bovine et d’analyser son impact économique. Au total, sur les 555 foies de bovins examinés à l’abattoir, 145 (26,1\%) étaient affectés par la distomiasse. Les espèces de douve recueillies des foies étaient identifiées comme étant Fasciola hepatica dans 23 foies (15,9\%), F. gigantica dans 83 (57,2\%) et les infections simples et mixtes des deux espèces dans 39 (26,9\%) foies. L’étude a montré qu’il n’y avait pas de rapport direct entre le nombre de douves et l’ampleur des lésions hépatiques dans les foies plus ou moins affectés.

Une autre analyse sur les dommages causés ou l’ampleur des lésions sur les foies par rapport aux espèces de douve collectées n’a montré aucune différence significative (P > 0,05). On n’a observé aucune variation notable (P > 0,05) de la prévalence mensuelle de la maladie. Les pertes économiques subies à cause de la distomiasse bovine qui a entraîné la condamnation des foies (impropres à la consommation) et la perte de poids de la carcasse pendant les cinq mois qu’a duré l’étude étaient estimées à 27.231 Birr Ethiopean (4.538,5 $ EU), ce qui représente environ une perte de 187,8 Birr Ethiopean (31,3 $ EU) par tête de bovin abattue à l’abattoir. Ces pertes sont considérables dans un milieu semi-árid où la distomiasse est considérée comme un problème moins grave. Fasciola gigantica s’est avérée une espèce de douve importante, causant la distomiasse chez les bovins dans le sud du Tigré.

Mots-clés : prévalence, impact économique, distomiasse bovine, abattoir, Mekelle, Ethiopie

Summary

A survey was carried out at Mekelle Municipal abattoir in Tigray region, northern Ethiopia, from October 1994 to February 1995. It was carried out to determine the prevalence of bovine fasciolosis and to examine its economic impact. A total of 555 bovine livers were examined in the abattoir and 145 (26.1\%) were found to be affected by fasciolosis. Fluke species recovered from livers were identified as Fasciola hepatica, 23 (15.9\%) and, F. gigantica in 83 (57.2\%) as single infections and mixed infection of both species in 39 (26.9\%) of the livers. The study showed that there was no direct relationship between fluke count and magnitude of hepatic lesions in moderately affected livers.

Further analysis on the damage inflicted or extent of the lesions in the livers in relation to the fluke species recovered revealed no significant difference (P>0.05). No significant variation (P>0.05) in monthly prevalence of the disease was also observed. The economic loss incurred as a consequence of bovine fasciolosis due to liver condemnation and carcass weight loss during the five months of the study period was estimated to be Ethiopian Birr 27,231.00 (US$ 4,538.5). This accounted to an estimated loss of Eth. Birr 187.8 (US$ 31.3) per head of cattle slaughtered in the abattoir which was quite considerable in a semi-arid environment where fasciolosis is considered to be less of a problem. Fasciola gigantica was found to be an important fluke species causing fasciolosis in cattle in southern Tigray.

Keywords: Prevalence/economic impact/bovine fasciolosis /abattoir/Mekelle/Ethiopia.
Introduction

Ethiopia has a huge livestock resource due to the various agro-ecological zones that make the country suitable for livestock production. The country has approximately 17% of cattle, 15% of sheep and goats and 49% of equine population of Africa. Livestock raising is an important economic activity and is a source of milk and meat, and other non-food commodities such as power, manure, hides and skin and cash income.

Parasitism is one of the major bottlenecks to livestock development in the tropics in general and in Ethiopia in particular. Among many parasitic problems of farm animals, fasciolosis is a major disease, which imposes direct and indirect economic impact on livestock production particularly of sheep and cattle. Bovine fasciolosis is an economically important trematode infection of cattle caused by the liver flukes *F. hepatica* and *F. gigantica*, whose life cycles involve snail intermediate hosts. Preliminary data on economic loss due to fasciolosis in cattle indicates a reduction in production efficiency by 8% and over 20% in mild and severe infections respectively. Acute losses associated with fasciolosis have also been recorded in cattle in East Africa. It causes a substantial economic loss, which include; death, loss in carcass weight, reduction in milk yield, condemnation of affected livers, decline in production (reproductive) performances, predisposition to other diseases and cost of treatment.

Surveys have been carried out on fasciolosis in various parts of Ethiopia to determine the prevalence and its economic significance. However, Tigray region (found in the northern part of Ethiopia) has been an exception mainly because of the war waged for 17 years. Therefore, this study was conducted with two objectives, that is to determine the prevalence of fasciolosis in cattle slaughtered at Mekelle Municipal abattoir and to estimate the economic loss incurred due to the disease.

Materials and Methods

Study site

The study was carried out at Mekelle Municipal abattoir, Tigray regional state, from October 1994 to February 1995. Tigray is located in the northern part of Ethiopia which extends from latitude 12° 13' to 14° 54' North and from longitude 36° 27' to 40° 18' East. Mekelle, the capital of Tigray region, is situated at 39° 29'E and 13° 30'N at an altitude of 2070 meters above sea level.

The region has a semi-arid type of environment with a marked variation in rainfall from East to West. The mean rainfall varies from less than 200 mm in the eastern extreme on the border of Danakil depression to over 1200 mm in the southwestern part of the region.

During summer, the lowlands of eastern Tigray have a mean temperature of 27.5°C. The extreme western part with an altitude below 1000 meter above sea-level and the slopes of the great escarpment running north-south in central Tigray have mean temperatures of 25°C and 20°C respectively. Generally, the region experiences bimodal rainfall and has 3 main seasons. These are the “dry season” that lasts from October to January, the “short rainy season” occurring from beginning of February to the end of April and the “long rainy season” which extends from July to end of September.
Study animals
The study animals comprised 555 heads of indigenous zebu cattle slaughtered at Mekelle Municipal abattoir. Being trade animals, the cattle were brought to the abattoir from distant areas covering long journeys. Almost all cattle slaughtered in the abattoir came from southern Tigray, which includes areas around Maichew, Korem, Raya and Azebo district. A very small proportion of cattle, which did not meet the minimum sample size required, was slaughtered from areas in and around Mekelle town. Thus cattle originating from the southern part of Tigray were considered for the study.

Ante mortem inspection
Three visits were made in a week to the abattoir for sample collection. During every visit each animal was given an identification number. No particular attention was given to factors such as sex and age since almost all the cattle presented for slaughter were males and aged.

Post mortem examination
After a thorough inspection, palpation and systematic incision of each liver, positive cases were taken apart and detailed examinations were undertaken. Those included; a) Determination of the extent of lesions in affected livers. The extent of lesion was graded as light, moderate and severe based on the approach of Ogunrinade19, b) Determination of fluke burden. The method of Hammond and Swell was utilized for recovery and counting of flukes20 c) Identification of Fasciola species using measurements provided by Soulsby21.

Assessment of economic Loss due to fasciolosis

Direct loss due to liver condemnation
The rate of liver condemnation was obtained from the prevalence of the disease and the market price per Kilogram of a liver, Eth. Birr 6 (US$ 1), was determined from interviews made with local butchers at Mekelle town.

Thus, Direct loss = TNA x PF x AWP L
Where, TNA = Total number of Animals slaughtered
PF = Prevalence rate of fasciolosis at the abattoir
A WP L = Average price of a liver at Mekelle town

Indirect loss due to carcass weight loss
An estimated 10% carcass weight loss due to fasciolosis given by Henderson and Wetzel and the average carcass weight of Ethiopian zebu, 126 kg were considered to compute the carcass weight loss due to the disease22,23. The average price per kilogram of beef at Mekelle town, Eth. Birr 13 (US$ 2.17), was obtained from an interview made with local butchers.

Thus, carcass weight loss = TNA x PF x A v C W T x 10% x P B
Where; TNA = Total No. of slaughtered cattle considered for the study
PF = Prevalence of Fasciolosis
A v C W T = Average carcass weight of Ethiopian Zebu
P B = Average price per kilogram of beef at Mekelle town.

Statistical analysis
The test statistics used were mean (x), percentage (%) and chi-square test of
independence to compare *Fasciola* species with respect to their pathogenic effect on livers and to compare monthly prevalence rates of fasciolosis.

**Results**

In this study, out of a total of 555 indigenous heads of cattle examined, 145 (26.1%) were found affected with fasciolosis. An assessment made on severity of lesions on the infested livers with respect to *Fasciola* species showed that 23 (15.9%) were due to *F. hepatica* of which 43.5% were with severe, 17.4% moderate and 39.1% with light lesions. Eighty three (57.2%) of the infested livers were due to *F. gigantica* of which 32.5% were with severe, 36.1% moderate and 31.4% with light lesions. Thirty nine (26.9%) were with mixed infections, 38.5% of which were with severe, 23.2% with moderate and 38.5% with light lesions. The result indicated that there was no significant difference (P>0.05) between *Fasciola* species with respect to severity of lesions. A study made on affected livers to see the possible relationship between fluke burden and extent of lesion revealed mean fluke burdens of 32.4, 184 and 87.2 on livers with light, moderate and severe lesions respectively.

The variation in monthly prevalence of fasciolosis was estimated and found to be 28.6% in October, 25.2% in November, 28.6% in December, 25.6% in January and 24.6% in February. The differences among monthly prevalence were insignificant (P>0.05). Estimation of the economic loss indicated a loss of Ethiopian Birr 3480 (US $ 580) due to liver condemnation and 23,751 (US $ 3958.5) due to carcass weight loss.

**Discussion**

Fasciolosis is known to be an important livestock disease in different parts of the world. In Africa reported prevalence rates are 33% in Kenya, 37% in Sudan, 45% in Cameroon, 16% in Uganda, 50% in Rwanda, 62% in Central Africa Republic and 30-90% in Ethiopia. In addition, fasciolosis is reported in almost all regions of Ethiopia. The prevalence rate obtained in Tigray region was lower than the reports of several workers in different parts of Ethiopia who reported prevalence rates ranging from 27-88.6%. The lower prevalence rate recorded in this study may be due to the semi-arid nature of the environment in which conducive ecological factors for the development and multiplication of the intermediate host snails might be absent.

The absence of significant difference between *Fasciola* species in their pathogenic effect contradicts earlier findings that indicated fibrosis, hyperplasia, and calcification of bile ducts to be particularly severe in *F. gigantica* infections than to *F. hepatica* infections. In this particular study, higher fluke counts of *F. hepatica* were found than *F. gigantica* and also higher proportions of *F. hepatica* was found than those of *F. gigantica* in mixed infections. This may be due to the local managemental or environmental conditions that might have increased the animals’ chance of acquiring greater number of *F. hepatica* metacercariae than *F. gigantica* metacercariae. Marshy areas created due to the receding water of Lake Ashenge, 3000 meters above sea level, provide ideal habitats for the intermediate host of *F. hepatica*. These sites serve as good
sources of pasture where a number of animals frequently congregate during the dry season. This might have resulted in a higher challenge of animals with metacercariae of *F. hepatica* than those of scattered small permanent watering sites, ideal habitats for *Lymnaea natalensis*, in the lowlands of the region which may be less frequently visited by animals or they may have a limited number of snail population.

In this study a higher proportion (57.2%) of the infection was found to be due to *F. gigantica* followed by mixed infection of both species indicating *F. gigantica* as the predominant species. The frequent occurrence of *F. gigantica* may be ascribed to the ecology of its intermediate host, *L. natalensis*. *Fasciola gigantica* occurs wherever ecological conditions are favorable and does not reside in temporary pools and water courses that disappear in dry season\(^27\). In Tigray region, many temporary watering and swampy areas disappear during the dry season and hence, few localized permanent-watering sites in the low lands of southern Tigray may serve as an ideal habitat for the aquatic snail *L. natalensis*. During the dry season animals congregate at permanent watering points and this might have resulted in the frequent occurrence of *F. gigantica* in cattle of southern Tigray.

The mixed infection observed may be attributed to the local climatic conditions where the animals originated allowing the co-existence of both species of *Fasciola* and husbandry practices that may increase the animals' chances of acquiring both infections. The origin of most study animals, i.e. the lowlands of southern Tigray, has altitudes ranging from 1200-1800 meters above sea level which is favorable for the co-existence of both *F. hepatica* and *F. gigantica\(^25\). Cattle movements from lowlands to highlands of the region and vice versa in search of better grazing might also have contributed to the mixed infection.

The higher average fluke burden obtained on moderately affected livers than on severely affected ones is in agreement with the findings of previous works\(^28\). Severe fibrosis impedes passage of immature flukes while acquired resistance and calcification of bile ducts result into the expulsion of adult flukes\(^28\).

The insignificant variation in monthly prevalence of bovine fasciolosis may be attributed to the short study period that only included months of the dry season. During the dry season as there is scarcity of feed, most of the animals in southern Tigray are forced to graze on localized marshy areas and regularly visit small permanent water sources. These watering points and marshy areas may act as important and continuous source of infection throughout the dry period. Moreover, *Fasciola* may live in cattle for about 2 to 3 years\(^25, 29\) resulting in continuous contamination of watering points with *Fasciola* eggs which may lead to the maintenance of the infection with an almost steady prevalence throughout the dry period.

The average economic loss in Eth. Birr 187.8 (US$ 31.3) incurred per head of cattle slaughtered in the abattoir due to liver condemnation and carcass weight loss was higher than the mean values ranges of Eth. Birr 32-159 (US$ 5.33-26.5) reported earlier\(^8-15\). This indicated that the estimated loss due to the disease in the abattoir was quite considerable in an area of semi-arid environment such as Tigray where fasciolosis is considered to be of less a challenge. As this is the first survey of its kind for the region that indicated the prevalence and economic
significance of the disease, further study on the epidemiology of the disease is required for establishment of an effective control program.

Acknowledgements

The authors would like to thank the staff of Mekelle Municipal abattoir for their kind cooperation during the study.

References

17. Sustainable Agricultural and Environmental Rehabilitation of Tigray (SAERT), (1993).
COMPARATIVE STUDY ON THE PATHOGENICITY AND PATHOGENESIS OF INFECTIOUS BURSAL DISEASE VIRUS IN LOCAL AND EXOTIC BREEDS OF CHICKENS

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ETUDE COMPARATIVE SUR LA PATHOGENICITE ET LA PATHOGENESE DU VIRUS DE LA MALADIE INFECTIEUSE DE LA BOURSE CHEZ LES RACES LOCALES ET EXOTIQUES DE POULET

Résumé

Une étude comparative a été menée pour déterminer la pathogénicité du virus de la maladie infectieuse de la bourse (VMIB, souche sauvage) et la pathogénèse de la maladie chez les races locales de poulet (Baladi) par rapport aux races exotiques. Les poulets Baladi, soumis à une infection expérimentale à VMIB, ont développé une infection infraclinique, ce qui est une preuve de résistance relative. Les lésions macroscopiques de MIB chez les poulets locaux étaient similaires à celles observées chez les poulets exotiques mais moins graves. Les lésions histopathologiques dans la bourse de Fabricius et les reins des deux races étaient les mêmes.

Avec le test d'immunofluorescence indirecte, on a d'abord détecté l'antigène viral 6 heures après l'infection dans le jéjunum et les glandes du caecum des poulets exotiques infectés, alors qu'il a été dépisté plus tard (12 heures après l'infection) dans le duodénum des poulets Baladi infectés. L'antigène viral dans la bourse de Fabricius et les autres organes lymphoïdes chez les deux races était détecté 24 et 48 heures après l'infection. On n'a pas dépisté d'antigène viral dans les reins examinés.

Summary

A comparative study was conducted to determine the pathogenicity of infectious bursal disease virus (IBDV) (field strain) and the pathogenesis of the disease in local breeds of chickens (Baladi) compared to exotic ones. The Baladi chickens, on experimental infection with IBDV, developed subclinical infection indicating relative resistance. The gross lesions of IBD in local chickens were similar to those observed in exotic chickens but were less severe. The histopathological lesions in the Bursa of Fabricius and kidneys of both breeds were similar.

Using indirect immunofluorescent test, the viral antigen was first detected 6 hours post infection in the jejunum and caecal tonsils of infected exotic chickens, while it was detected later (12 hours post infection) in the duodenum of infected Baladi chickens. Viral antigen in the bursa of Fabricius and other lymphoid organs in both breeds were detected at 24 and 48 hours post infection. The viral antigen was not detected in any of the examined kidneys.

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Introduction

Infectious bursal disease (IBD), an acute viral disease of young chickens, was first reported in 1962. It causes suppression of the immune system, anorexia, depression and occasionally nephrosis. The aetiological agent, infectious bursal disease virus (IBDV) was classified within the family Birnaviridae.

Clinical IBD most commonly recognized in susceptible 3-6 weeks old birds, has a short incubation period and an acute course characterized by a high morbidity and variable mortality rates. The disease was shown to affect the lymphoid organs of the chickens, primarily the Bursa of Fabricius, which at the early stages becomes enlarged up to five times its normal size and becomes oedematous, hyperaemic and cream colored with prominent striations.

Following oral infection, the virus replicates in gut-associated macrophages and lymphoid cells from which it enters the portal circulation, leading to primary viraemia. Within 11 hours of infection, viral antigen is detectable in the bursal lymphoid cells, but not in lymphoid cells of other tissues. Large amounts of the virus released from the bursa produce secondary viraemia resulting in localization in other tissues.

In Sudan, IBD was first reported in Obeid town in 1982. The outbreak occurred in exotic, crosses and local chickens. Since then outbreaks have been reported in exotic chickens from many parts of the country. No clinical cases of IBD have been reported among indigenous chickens despite the fact that the serological evidence of IBDV infection in local chickens has been documented.

The objective of this investigation was to study the susceptibility and pathogenesis of local chickens to experimental infection with IBDV in comparison to that in an exotic breed.

Materials and Methods

Chicks

One-day old exotic chicks of Bovan breed were obtained from Coral Farm Hatcheries and the local chickens (Baladi), were obtained from a commercial supplier.

All chicks used were tested and confirmed as free from IBD antibodies using agar gel precipitation test (AGPT). They were reared in isolation units under similar management conditions.

Viruses

Infectious bursal disease virus (IBDV) field strain

IBDV was isolated from an outbreak that occurred at ElGeraif- west, Khartoum State in 1999 from 2-months old chicks. The isolated virus was identified by AGPT as IBDV and labelled (G/99). Its chicken infectious dose 50 (CID 50 ) and embryo infectious dose 50 (EID 50 ) were 10 6.5 and 10 6.2 /ml respectively.

Chicken Immunoglobulin G (IgG) conjugated with Fluorescein

IgG was obtained from Nordic Immunological Laboratories in the Netherlands in a lyophilized form. The IgG conjugate was reconstituted in 2-ml distilled water and a working solution of 1:400 prepared in phosphate buffered saline (PBS).

The pathogenicity of IBDV (field isolate) in local and exotic chickens.

Thirty-two Baladi and forty-five exotic 5-weeks old chicks were used. Birds of
each breed were divided into two groups as follows:
Group (1): consisted of 22-Baladi and 30 exotic chicks.
Group (2): consisted of 10 Baladi and 15 exotic chicks.

Each chick in group one received 0.1 ml of 10⁴ChID₅₀/dose of the IBDV (G/99) divided equally via intraocular (I/O) and intranasal (I/N) routes. Chicks in group two were left as unoinculated control. All chicks were observed for 10 days. The incubation period, clinical signs, morbidity and mortality rates were recorded. On days one, three, four and fifteen post infection (PI), four Baladi and four exotic chicks from group one, and two Baladi and two exotic chicks from group two were sacrificed for post mortem examination.

**Histopathology**

On days 3 and 4 PI, the bursae and kidneys were removed from chicks in both groups and fixed in 10% formalin, processed for histopathological examination, and stained with Haematoxylin and Eosin.

**Serology**

Sera were collected from the two groups of chickens 1-3 weeks PI and tested for IBD antibodies by AGPT as described elsewhere.

**Pathogenesis of IBDV (field isolate) in local and exotic chickens**

Forty-eight 5-weeks old chicks (24 Baladi and 24 exotic) were used. Sixteen chicks from each breed were inoculated with 0.1 ml of 10⁴ChID₅₀/dose of the IBDV (G/99) I/O and I/N. Eight chicks from each breed were left as control. After 6, 12, 24 and 48 hours PI, eight inoculated chicks (4 Baladi & 4 exotic) and four from the controls (2 Baladi & 2 exotic) were killed. Bursae, spleen, thymus, caecal tonsils and kidneys in addition to the duodenum and jejunum were removed aseptically, placed in sterile bijou bottles and stored at −20°C before immunofluorescent staining.

**Indirect immunofluorescent test**

The intact bursae, spleen, thymus, caecal tonsils, kidneys, duodenum and jejunum were cut with sterile scalpel and a smear from the inner surface of each organ was made on clean glass slides. The smears were stained by fluorescein as described earlier.

**Results**

**Comparative pathogenicity of IBDV field isolate in experimentally infected local and exotic chickens**

Table 1 shows the incubation period, number of birds showing clinical signs,

<table>
<thead>
<tr>
<th>Types of Chickens</th>
<th>No. of Chickens used</th>
<th>Incubation Period (days)</th>
<th>No. showing clinical signs</th>
<th>Morbidity %</th>
<th>Mortality %</th>
<th>Course (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baladi</td>
<td>22</td>
<td>3-4</td>
<td>15</td>
<td>68.2</td>
<td>Zero</td>
<td>7</td>
</tr>
<tr>
<td>Exotic</td>
<td>30</td>
<td>2-3</td>
<td>30</td>
<td>100</td>
<td>3.8</td>
<td>7</td>
</tr>
</tbody>
</table>

Table 1: The pathogenicity of IBDV (G/99) in experimentally infected 5-week old susceptible Baladi and exotic chickens on day 4 PI.
Table 2: Post mortem lesions of 5-week old Baladi and Exotic infected with IBDV (G/99)

<table>
<thead>
<tr>
<th>Days post infection</th>
<th>1</th>
<th>3</th>
<th>4</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post mortem lesions</td>
<td>Baladi</td>
<td>Exotic</td>
<td>Baladi</td>
<td>Exotic</td>
</tr>
<tr>
<td>Hemorrhages in muscles</td>
<td>0/4</td>
<td>1/4</td>
<td>1/4</td>
<td>2/4</td>
</tr>
<tr>
<td>Bursal lesions</td>
<td>0/4</td>
<td>0/4</td>
<td>2/4*</td>
<td>3/4*</td>
</tr>
<tr>
<td>Spleen lesion</td>
<td>0/4</td>
<td>0/4</td>
<td>0/4</td>
<td>2/4</td>
</tr>
<tr>
<td>Hemorrhage at Proventriculus</td>
<td>0/4</td>
<td>0/4</td>
<td>0/4</td>
<td>0/4</td>
</tr>
<tr>
<td>Kidney lesions</td>
<td>0/4</td>
<td>0/4</td>
<td>0/4</td>
<td>0/4</td>
</tr>
</tbody>
</table>

*Enlarged Bursa
**Atrophied Bursa
morbidity and mortality rates and the course of IBD in experimentally infected local and exotic chickens.

**Post mortem lesions**

The lesions in both breeds as recorded in Table 2, consisted of haemorrhages in the thigh and pectoral muscles, enlarged bursa with pale yellowish colour and gelatinous transudate and prominent striations which were evident on days 3 and 4 PI; some bursae showed haemorrhages. Fifteen days PI, all bursae of infected chickens showed signs of atrophy. Some birds showed haemorrhages at the junction of the proventriculus and gizzard. The spleen was enlarged and mottled. Kidneys were oedematous, discoloured (pale) with deposition of urates. The control groups showed no IBD lesions.

**Histopathological lesions**

The bursa of Fabricius of infected Baladi and exotic chickens on day 3 and 4 PI showed oedema and intense infiltration of mononuclear cells, the majority of which were lymphocytes, plasma and macrophage cells. The lymphoid follicles showed degeneration, atrophy and necrosis at the medulla with cyst formation. Some of these cysts were filled with homogenous necrotic material and/or necrotic tissue debris. Haemorrhages were occasionally observed in the connective tissues and between the dissociated follicular cells.

Changes in the kidneys of both breeds of chickens (on days 3 and 4 PI) consisted of oedema and haemorrhage in the interstitial tissues. Some tubules showed necrosis and detachment of the epithelial lining. There was effusion and aggregation of mononuclear cells in the interstitial areas. In some areas the normal kidney tissues were devastated and replaced by oedema and extra-vascular erythrocytes.

**Humoral immune response**

IBD antibodies were first detected on the eighth day PI in the sera of all infected Baladi (10/10) and exotic (17/17) chickens. All uninoculated control Baladi and exotic birds' sera were negative for IBD antibodies.

<table>
<thead>
<tr>
<th>Table 3: Indirect immunofluorescent study of organs of experimentally IBDV infected Baladi and Exotic chickens</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organ examined</strong></td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Doudenum</td>
</tr>
<tr>
<td>Jejunum</td>
</tr>
<tr>
<td>Caecal tonsils</td>
</tr>
<tr>
<td>Bursa</td>
</tr>
<tr>
<td>Spleen</td>
</tr>
<tr>
<td>Thymus</td>
</tr>
<tr>
<td>Kidneys</td>
</tr>
</tbody>
</table>

+ Positive specific fluorescence.
- Negative specific fluorescence.
NT Not tested
till the end of the experiment (3 weeks).

*Pathogenesis of IBDV (G/99) in local and exotic chickens.*

The results of detection of viral antigen in the tissues of the duodenum, jejenum, caecal tonsils, bursa of Fabricius, spleen, thymus and kidneys of local and exotic chickens are shown in Table (3).

**Discussion**

Pathogenicity of IBDV is defined as the replication of the virus in the cells of the bursa of Fabricius and other lymphoid organs. In this study, pathogenicity of IBDV in experimentally infected local (Baladi) and exotic breeds of chickens was compared. The two breeds used were of the same age and were given similar virus doses administered by the same routes i.e. the intranasal and the intraocular.

The results confirmed the presence of typical IBDV lesions in sacrificed infected Baladi and exotic chickens. These lesions were less severe and were detected later after infection in the Baladi compared to those in the exotic chickens. The histopathological lesions in the bursa of Fabricius and kidneys were the same in both breeds. The microscopic lesions in bursa of Fabricius were as previously described\(^4,11\).

The course of the disease in the two breeds was seven days. IBDV specific antibodies were detected in sera of infected birds from the eighth day post infection. The early appearance of serum antibodies may reduce the severity of infection through virus neutralization\(^12\).

It could be concluded that the local breed of chickens suffered only subclinical infection with some relative resistance when experimentally infected with IBDV. They were symptomless but showed gross and microscopic lesions of IBD. In addition, they experienced sero-conversion to IBD infection. These findings in local chickens agreed with the results obtained in a previous work, where the first outbreak of IBD in Sudan was reported\(^5\). The investigators observed that, although the clinical picture in local chickens involved in the outbreak were less severe post mortem lesions were observed. Moreover, the mortality rate was lower than that recorded in other breeds. Also it was reported that local chickens in Sudan have greater ability to resist common endemic diseases\(^13\).

The susceptibility of local Nigerian chickens to IBD infection was studied\(^14\). The workers found that the local chickens when put in contact with infected exotic cockerels showed only weight loss and depression, which appeared later than that of cockerels. The mortality rate was lower than that of cockerels and exotic broiler chicks introduced in the same pen.

The results of detecting IBDV antigen in the duodenum, jejenum and caecal tonsils by the indirect immunofluorescent test agreed with the earlier findings that these organs were the areas of primary affinity\(^15\). Viral antigen has been detected in macrophages and lymphatic cells of the caecum 4 hours PI and of the duodenum and jejunum at 5 hours PI\(^15\). In the present study, viral antigens were detected in all lymphoid organs of exotic breed and only in the bursa of Fabricius of Baladi chicks at 24 hours PI. Viral antigens were detected in all lymphoid organs of exotic and Baladi chickens except the thymus 48 hours PI.

The observation that positive fluorescent reaction on the thymus of exotic chickens which was seen 24 hours but not 48 hours was explained in a previous investigations that T-cells are either totally refractory or have very low susceptibility to IBDV\(^16\). It should be stated that, in this study, IBD viral
antigen was not detected in kidney tissues in any of the experimental birds and that this could not be explained.

The presence of viral antigens in the lymphoid organs of Baladi chickens indicated replication of the virus in these organs, although it was detected later than that in exotic chickens and not seen at all in the thymus. This suggests that local chickens might have relative resistance to IBD infection.

These results generally agreed with previous observations. The authors stated that the frequency of detection of virus antigen in the thymus was lower than in the bursa of Fabricius. The results of the detection of viral antigens in the bursa of Fabricius agreed with the earlier findings where the viral antigen in bursa of Fabricius was demonstrated 48 hours PI. In other relevant work IBDV antigen was detected in the bursa of Fabricius and spleen from 24-36 hours PI.

In another study, the investigators detected the viral antigens in the bursa of Fabricius 48 hours PI in chickens experimentally infected with G23 strain, and 4 days PI in other chickens infected with G13 strain. Moreover IBDV antigen was seen in the bursa of Fabricius 11 hours PI onwards.

The rationale behind this study was to examine and confirm the merits of local chickens over exotic ones. Local chickens are relatively resistant to many endemic infections. Moreover they are considered to tolerate better low standards of poultry management compared to exotic breeds.

References


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EVALUATION OF ENERGY AND PROTEIN VALUE OF WHOLE CASSAVA PLANT MEALS IN GROWING PIG DIETS IN THE TROPICS

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EVALUATION DE LA VALEUR ENERGETIQUE ET PROTEIQUE DU MANIOC ENTIER CHEZ LES PORCS A LA CROISSANCE SOUS LES TROPIQUES

Résumé

Une expérience a été faite afin d’évaluer la substitution du maïs au manioc entier (ME) dans les régimes des porcs à la croissance à travers l’utilisation de l’énergie et des protéines pendant huit semaines. Trois régimes ont été proposés : le régime 1 à base de maïs était utilisé comme régime-témoin, le régime 2 contenait 40% de ME, tandis que le régime 3 avait 60% de ME. Vingt-quatre porcs étaient servis au hasard avec les trois régimes expérimentaux. Le régime 1, régime-témoin à base de maïs, était comparé : au régime 2 composé en partie de maïs et de résidus de maïs remplacés par ME et au régime 3 composé intégralement de maïs et de résidus de maïs substitués au ME. Au terme de l’étude, la consommation de matière sèche/jour (891 – 903 g), les gains pondéraux/jour (384 – 411g), la protéine totale (6,10 – 6,25 g/dl), l’urée dans le sérum (18 – 20 mg/dl), la consommation d’énergie métabolisable/kg gain (26,76 – 29,02 JM/kg), le cholestérol (181,5 – 184 mg/dl) et le glucose (69,5 – 71 mg/dl) ainsi que d’autres indices d’utilisation d’énergie et de protéine n’étaient pas beaucoup influencés (P > 0,05) par les régimes alimentaires. Les résultats de la présente étude montrent que ME peut être inclus dans le régime des porcs à la croissance à hauteur de 60% pour remplacer le maïs sans aucun effet négatif sur les indices d’utilisation d’énergie et de protéine.

Summary

The experiment was conducted to evaluate the maize replacement value of whole cassava plant meal (WCPM) in growing pig diet through energy and protein utilization for a period of eight weeks. Three diets were formulated. Diet 1 was maize based and served as control. Diet 2 contained 40% WCPM while diet 3 contained 60% WCPM. Twenty four pigs were randomly distributed to three experimental diets using a completely randomized design.

The control maize based diet 1 was compared with diet 2 which had part of its maize and maize offal replaced with WCPM and diet 3 which had all the maize and maize offal replaced with WCPM. At the end of the study, the dry matter intake per day (891.0 to 903.0g), live weight gain per day (384 – 411g), total protein (6.10 – 6.25g/dl), serum urea (18.0 – 20.0 mg/dl), metabolisable energy intake per kg gain (26.76 to 29.02MJ/kg), cholesterol (181.5 to 184.0 mg/dl) and glucose (69.5 to 71.0mg/dl) and some other energy and protein utilization indices were not significantly (P> 0.05) influenced by dietary treatment. The results of this study suggest that WCPM can be included in the diet of growing pigs at even 60% of the diet to replace maize without any negative effect on the energy and protein utilization indices.

Introduction

The cost of feeding accounts for about 60 - 80% of total cost of production in intensive reared livestock production. This has resulted in giving consideration to the use of unconventional and less expensive feed ingredients for the feeding of livestock. Cassava offers tremendous potentials as a cheap source of feed energy and protein for livestock, provided it is well balanced with other ingredients. Cassava

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roots are a major source of carbohydrates. The bulk of the tuber (about 90%) consists of carbohydrates and the nitrogen free extract is made up of about 80% starch, the main soluble carbohydrate and 20% sugar⁴. Although the peel contains a higher level of crude protein than the tuber, the total protein concentration in the peel is low. The energy value varies with the amount of flesh retained during peeling process⁵. Cassava leaf on the other hand is rich in protein (25%) and the protein is of good quality, and the amino acid profile apparently compares favourably with that of soya bean meal. It is high in lysine but low in methionine⁶,⁷.

There is paucity of information on the inclusion of whole cassava plant (tuber, leaves and tender stems) in a single diet for pigs. Previous attempts have been on the use of either cassava flour or peels or leaves in the diets of pigs. The present study was designed to determine the effect of including flour, peels, leaves and tender stems together in the diets of growing pigs on the energy and protein utilisation indices.

Materials and Methods

Experimental Diets and Test Ingredients
Three diets were formulated to contain 19.0% crude protein and metabolisable energy (ME) value of about 12.3 MJ/Kg. Diet 1 was maize based and served as a control. Diet 2 had 40% WCMP to replace part of maize and maize offal. Diet 3 had 60% WCMP to replace all the maize and maize offal. The ratio of leaves to tender stem was 3:1 in both diets 2 and 3. The cassava flour, cassava peels and cassava leaves plus tender stems were obtained from harvested matured cassava plant from neighbouring farms around the University of Ibadan Teaching and Research Farm.

The cassava tuber, after harvesting, was peeled and chopped into bits and sun dried to about 10% moisture content before milling. The cassava peels were collected fresh after peeling and sun-dried to about 10% moisture content before milling. The cassava leaves plus tender stems were collected fresh after harvesting, chopped into bits with cutlass and sub-dried to about 10% moisture content before milling. Table 1 shows the gross composition of experimental diets.

Management of Experimental Animals
A total of twenty-four growing pigs (Large white X Hampshire) weighing 12.50 ± 0.32kg on average were randomly distributed to three experimental diets of eight animals per treatment with each serving as a replicate. The experiment was conducted for eight weeks. The animals were individually housed in a concrete floored pen equipped with watering and feeding facilities. Each experimental diet was fed to the animals at 3 – 5% of their body weights twice daily at 0.9.00a.m and 02.00p.m. throughout the duration of the study. Water was provided for the animals ad libitum. Routine management practices were followed throughout the study period. Records of feed consumption and weight gained each week were taken on a treatment basis.

Blood Collection
At the end of the eight week of the growth trial, four animals from each treatment were isolated for the purpose of blood collection. The animals were fasted overnight. Blood samples were collected from individual animals with the aid of sterilized 10 – gauge needles inserted through the anterior vena cavae. The bleeding was done into test tubes in the
Table 1: Composition of experimental diets (%)

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Maize</td>
<td>30.00</td>
<td>20.00</td>
<td>-</td>
</tr>
<tr>
<td>Maize offal</td>
<td>30.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cassava flour</td>
<td>-</td>
<td>20.00</td>
<td>40.00</td>
</tr>
<tr>
<td>Cassava peel meal</td>
<td>-</td>
<td>10.00</td>
<td>10.00</td>
</tr>
<tr>
<td>Cassava tender stem + leaf meal</td>
<td>-</td>
<td>10.00</td>
<td>10.00</td>
</tr>
<tr>
<td>Groundnut cake (GNC)</td>
<td>20.00</td>
<td>20.00</td>
<td>20.00</td>
</tr>
<tr>
<td>Palm kernel cake</td>
<td>14.50</td>
<td>13.25</td>
<td>11.00</td>
</tr>
<tr>
<td>Fish meal</td>
<td>1.50</td>
<td>1.50</td>
<td>1.50</td>
</tr>
<tr>
<td>Blood meal</td>
<td>0.50</td>
<td>1.75</td>
<td>4.00</td>
</tr>
<tr>
<td>Oyster shell</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Premix (Vitamin/minerals)*</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Salt</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Bone meal</td>
<td>1.50</td>
<td>1.50</td>
<td>1.50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

*Premix supplied per kg diet 4,000,000 i.u. Vit A, 800,000 i.u. Vit E, 0.80g Vit K, 0.60g Vit B, 2.0g Vit B1, 1.40 pantothenic acid; 20.00mg Biotin, 8.00mg Vit B6, 0.40g Folic acid, 120g choline chloride, 8.0g Zinc bacitracin, 40.00g Manganese, 20.00 Iron, 18.00g Zinc, 0.80g Copper, 0.62g Iodine, 0.09g Cobalt, 0.04g Selenium and 36.00g Lasalocid (Avatec).

morning before feeding. Each blood sample was allowed to clot before centrifuging to obtain serum used in the determination of the following serum metabolites using standard chemical procedures: Urea, Creatinine, Serum protein – Biuret method, Albumin, glucose and cholesterol.

Chemical and Statistical Analysis

The proximate analyses of the diets were carried out using the procedure of AOAC (Table 2). All results were subjected to analysis of variance using computer software package. The cyanide level of the diets was determined using methods outlined by ISO.

Results

Results of the experiment are shown in Tables 3 and 4. The analyses revealed that weight gain, protein efficiency ratio, metabolisable energy intake per kg gain, total serum protein, serum urea, serum creatinine, serum glucose and cholesterol, were not significantly (P>0.05) affected by the dietary treatments.

The daily weight gain, which ranged from 384 g to 411 g per day decreased though insignificantly (P>0.05) with the increasing levels of whole cassava plant. The lowest growth responses were obtained with pigs on diet 3 (60% whole cassava plant inclusion) while the highest
Table 2: Proximate composition of experimental diets (%)

<table>
<thead>
<tr>
<th>Parameters (%)</th>
<th>Experimental Diets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Dry Matter</td>
<td>91.57</td>
</tr>
<tr>
<td>Crude protein</td>
<td>19.70</td>
</tr>
<tr>
<td>Crude fibre</td>
<td>8.48</td>
</tr>
<tr>
<td>Ether extracts</td>
<td>1.96</td>
</tr>
<tr>
<td>Ash</td>
<td>11.37</td>
</tr>
<tr>
<td>Nitrogen free extracts</td>
<td>58.49</td>
</tr>
</tbody>
</table>

was obtained with pigs on diet 1 (maize based control diet).

Results of feed consumption which ranged from 891 g to 903 g per day, showed that the animals consumed more with the increasing levels of whole cassava plant in the diet though insignificantly (P>0.05). The results of the feed to gain ratio (2.71 to 2.35) showed an improvement (P>0.05) of diet 1 over diets 2 and 3.

The protein intake per day (187 g to 194 g) protein efficiency ratio (2.02 to 2.15), metabolisable energy intake per day (10.92 to 11.28 MJ/kg) energy intake per kg gain (26.79 to 29.02 MJ/kg) were not significantly (P>0.05) influenced by dietary treatments. The serum metabolites, which indicate how the energy and protein of feed are utilized, showed no significant (P>0.05) difference. The serum creatinine decreased (P>0.05) from 1.0 mg/dl to 1.05 mg/dl with the inclusion of the whole cassava plant in the diets, while the serum urea increased (P>0.05) from 18.0 mg/dl to 20.0 mg/dl with the inclusion of the whole cassava plant in the diets. The cholesterol level of the blood increased (P>0.05) from 69.5 mg/dl to 71.0 mg/dl with the inclusion of the whole cassava plant in the diets while the glucose decreased (P>0.05).

All pigs remained healthy throughout the period of the study. There were no lesions or physical disabilities arising from the treatment effect.

Discussion

The results of the present study suggest that the partial and total replacement of maize with whole cassava plant in the diets of growing pigs had no negative effect on the dry matter intake, weight gain, feed to gain ratio, protein intake, protein efficiency ratio, ME intake per day and the serum metabolites. The fact that diet 1 (maize based) performed better, though not significantly, in all the growth indices monitored indicates that the inclusion of whole cassava plants in diets 2 and 3 does not have negative effect on the growth of the pigs. Besides, diet 2 which had partial replacement of maize was comparable to diet 1 in all the growth indices monitored. Despite the use of cassava at 40% and 60% the cyanide levels of the diets were below 50 parts per million (ppm). This could be as a result of proper processing. According to IITA, cassava processing can reduce the cyanogen content of roots and leaves of even the most potentially toxic varieties to safe levels. Satisfactory performance had been obtained when growing pigs were fed on fresh cassava rations containing less than 100 mg HCN
equivalent per Kg\textsuperscript{10}. The efficiency of feed utilization, which is a function of feed digestibility, was not significantly (P>0.05) affected. This may be due to adequacy of the crude protein and metabolisable energy both in quality and quantity in the diet.

The daily protein and metabolisable energy intake of pigs across the treatments was a function of dry matter (DM) intake because the diets were isonitrogenous and isocaloric. The similarity in the DM and protein intake resulted in comparable weight gains. This can be attributed to the efficient utilisation of the constituent protein and energy\textsuperscript{20}. Serum total protein, albumin and globulin of the growing pigs were observed to be unaffected by the inclusion of whole cassava plant. These parameters are indications of protein reserves in the animals and can be specifically influenced by protein shortage\textsuperscript{20,21}. The results of this study showed that the crude protein levels

\begin{table}[h]
\centering
\begin{tabular}{lccc}
\hline
\multicolumn{1}{c}{Parameters} & 1 & 2 & 3 \\
\hline
Dry Matter (DM) Intake/day (g) & 891.0±1.12 & 902.0±2.01 & 903.0±0.96 & NS \\
Initial live weight (kg) & 12.38±1.10 & 12.88±1.21 & 12.50±1.06 & NS \\
Final live weight (kg) & 35.40±3.68 & 34.78±2.95 & 34.0±2.49 & NS \\
Live weight gain (g/day) & 411.0±0.01 & 391.0±0.02 & 384.0±0.02 & NS \\
Feed to gain ratio & 2.17 & 2.31 & 2.35 & NS \\
Protein intake (g/day) & 191.0±0.04 & 194.0±0.03 & 187.0±0.04 & NS \\
Protein efficiency ratio (PER) & 2.15±0.46 & 2.02±0.60 & 2.05±0.52 & NS \\
Total serum protein (g/dl) & 6.1±0.08 & 6.25±0.04 & 6.10±0.08 & NS \\
Serum Albumin (g/dl) & 2.7±0.08 & 2.6±0.12 & 2.5±0.08 & NS \\
Serum Globulin (g/dl) & 3.4±0.16 & 3.7±0.16 & 3.7±0.17 & NS \\
Serum Creatinine (mg/dl) & 1.05±0.04 & 1.0±0.05 & 1.0±0.08 & NS \\
Serum Urea (mg/dl) & 18.0±1.02 & 19.0±0.82 & 20.0±1.63 & NS \\
\hline
\end{tabular}
\caption{Summary of protein metabolism and utilization values of growing pigs fed on maize and whole cassava plant based diets}
\end{table}

\begin{table}[h]
\centering
\begin{tabular}{lccc}
\hline
\multicolumn{1}{c}{Parameters} & 1 & 2 & 3 \\
\hline
ME of Diet (kcal/kg) & 2930 & 2960 & 2940 \\
ME intake per day (kcal/kg) & 2610.63 & 2696.98 & 2654.03 & NS \\
ME intake per kg gain & 6403.50±178.11 & 6909.93±287.99 & 6936.53±399.21 & NS \\
Cholesterol (mg/dl) & 181.5±1.25 & 184.0±4.08 & 182.5±2.07 & NS \\
Glucose (mg/dl) & 71.0±0.82 & 69.5±1.22 & 70.5±1.23 & NS \\
\hline
\end{tabular}
\caption{Energy Utilisation Indices of growing pigs fed experimental diets.}
\end{table}

NS: Not significant
of the diets were able to support normal protein reserves in the experimental pigs. Besides this, the observed values were consistent with average values reported\textsuperscript{22,23}. Serum creatinine and urea levels in animals which are indicative of muscular wastage\textsuperscript{24} were not affected negatively by the dietary treatments.

The serum cholesterol and glucose, which indicate the efficiency of utilisation of metabolisable energy in a given diet\textsuperscript{25,26} were similar in all the treatments. Fiber which is associated with the use of cassava peels, leaves and tender stems in monogastric feeds, has been implicated to cause reduction in blood glucose level\textsuperscript{27}. In this study, cassava cannot be sufficiently implicated in the lower values of glucose in the diets that contained whole cassava plant because, the values were consistent with average values.

The study suggests that whole cassava plant can be relied upon to replace maize in the diets of growing pigs without negatively affecting the energy and protein utilization indices.

Acknowledgement

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References

21. Gouache, P. Beatrice le Mollac, Fanny


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UTILIZATION OF MAIZE-OFFAL AS REPLACEMENT FOR MAIZE IN DIETS OF GROWING PIGS

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UTILISATION DES RESIDUS DE MAÏS COMME SUBSTITUTION AU MAÏS POUR LES REGIMES DES PORCS A LA CROISSANCE

Résumé

Trente-six porcs à la croissance Large White x Landrace âgés de 105 – 112 jours et pesant en moyenne 26,34 ± 0,989 kg étaient utilisés pour une expérience de 35 jours afin d'évaluer les métabolites dans le sérum et la digestibilité des substances nutritives des porcs à la croissance nourris de régimes contenant des niveaux croissants de résidus de maïs (RM) comme substitution au maïs. La consommation de matière sèche (MS) a augmenté (P<0,05) avec l'inclusion de RM, même si on a obtenu des valeurs comparables pour les régimes contenant 25% et 50% de RM. Les gains obtenus avec les régimes RM étaient nettement comparables (P > 0,05) à ceux du régime-témoin. Les taux de protéine totale dans le sérum, d'albumine, de globuline, de créatinine et d'urée ont montré qu'il y avait suffisamment de protéine dans le régime puisque RM n'avait pas d'effet négatif sur ces métabolites. On a eu les mêmes résultats avec les autres groupes. Les taux de cholestérol n'étaient pas non plus affectés. Toutefois, l'inclusion de RM a diminué (P < 0,05) les niveaux de glucose dans le sérum. Les digestibilités apparentes des substances nutritives dans les régimes n'étaient pas affectées (P > 0,05) par l'inclusion de RM. Les valeurs obtenues pour les régimes RM étaient comparables à celles du régime-témoin même si la consommation de matière sèche a augmenté (P < 0,05). Les porcs à la croissance peuvent donc tolérer à hauteur de 50% le remplacement du maïs par des résidus de maïs sans aucun effet négatif sur l'état de santé et l'utilisation des substances nutritives.

Summary

Thirty six Large White x Landrace growing pigs between 105-112 days of age, averaging 26.34±0.989 kg body weight were used in the 35 day trial to assess the serum metabolites and nutrient digestibilities of growing pigs fed diets containing graded levels of maize offal (MO) as a replacement for maize. The dry matter (DM) intake increased (P<0.05) with the inclusion of MO, though comparable values were obtained for the 25 and 50% MO diets. The gains obtained with the MO diets compared favourably (P>0.05) with those of the control. The serum total protein, albumin, globulin, creatinine and urea contents suggested the adequacy of the protein in the diet as the MO had no adverse effects on these metabolites. Comparable results were obtained across the groups. The cholesterol levels were equally unaffected. However, the MO inclusion decreased (P<0.05) the serum glucose levels. The apparent digestibilities of the nutrients in the diets were unaffected (P>0.05) by the MO inclusion. The values obtained for the MO diets were comparable to those of the control even when the DM intake increased (P<0.05). Thus, growing pigs can tolerate up to 50% replacement of maize with maize offal without any adverse effect on the health status and nutrient utilization.

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Introduction

Pigs grow fastest with the best feed conversion efficiency, when fed on high quality, correctly formulated diets\(^1\). In some situations, however, such as the scarcity, unavailability and the high prices of the conventional feedstuffs, a lower level of performance on cheap, waste or by-product feeds may be a more cost-effective way of producing pig meat\(^2\).

Maize offal has been shown in a previous experiment\(^3\), to make a substantial contribution towards better and more economic feeding of weaner pigs as an alternative feed source for high energy cereals such as maize. It is however, noteworthy that maize offal is fibrous in nature\(^4\) and it has the tendency of diluting the energy concentration of the high energy diet into which it is incorporated. The inclusion of fibrous ingredients result in bulky feeds. Pigs have potential for fibre utilization for growth as a result of microbial fermentation in the lower part of the gastrointestinal tract (Varel, 1987).

The influence of crude fibre on organic matter digestibility varies from feed to feed, depending on the special characteristics of the crude fibre in individual feeds\(^5\). The fibrous portion of feed, being fairly indigestible to pigs, influences the digestibility of the other constituents by exerting a protective action, against digestion.

In a previous experiment, weaner pigs, were able to tolerate up to 25% replacement of the maize portion with maize offal but not the 50%\(^3\). Growing pigs, being older than weaners and with more developed gastrointestinal tracts (GIT) are expected to tolerate more of the maize offal in their diets than the weaner pigs. It was, therefore, the objective of this study to assess the utilization of maize offal as a replacement for maize at different levels by growing pigs.

Materials and Methods

Experimental Diets

There were three dietary treatment groups in the experiment. These included the 0% maize offal (Maize-based) control and the replacement of the maize fraction with maize offal (MO) at 25 and 50% levels in the diet of growing pigs. The MO was added to replace 25 and 50% of the metabolisable energy (ME) supplied by maize in the control diet. The diets were formulated to contain 18% crude protein. The percentage composition of the experimental diets are as shown on Table1.

Experimental Animals.

Thirty six Large White and Landrace growing pigs between 105-112 days of age, averaging 26.34±0.989 kg body weight were used in the 35-days trial to evaluate the effect of MO as a replacement for maize on growth and digestibility of growing pigs. The pigs were injected subcutaneously with Ivermectin (Ivomec®) against endo-and exo-parasites (1ml/50kg liveweight). They were randomly allotted to the three treatment groups based on body weight, sex and litter origin in a completely randomised design.

Each group had 12 pigs comprising of six males and six females. All the pigs were housed on concrete floored pens equipped with feeding and watering troughs to allow ad libitum consumption of feed and water. The pigs were weighed and their feed intake
recorded weekly to allow the computation of their daily feed intake and weight gain.

**Chemical Analyses**

The test ingredient (Maize offal) and the resultant diets were analysed for their proximate components using the methods of the Association of Official Analytical Chemists\(^7\). The metabolisable energies were also determined with the equation\(^8\). The proximate components and metabolisable energies of the diets on dry matter basis are shown on Table 1.

**Blood Analyses**

Six (three males and three females) of the twelve experimental grower pigs in each of the three dietary treatments were randomly selected and bled at the end of the feeding trial. The bleeding was done in the morning before feeding and 10 ml of the blood was obtained from the jugular vein into a sample bottle using a sterilized needle and syringe\(^9\). The samples were allowed to clot before centrifuging to obtain the serum used in the determination of some serum metabolites\(^10,11\).

**Digestibility Studies**

Three males in each of the three dietary treatment groups were used in a digestion trial in a completely randomised design. The pigs were housed individually in metabolism cages for a five-day adjustment period and four-day total collection of faeces. The faeces were collected and 10% of daily collections were frozen. At the end of the digestibility trial,

| Table 1: Composition (%) of growing pig diets with graded levels of maize offal level of maize offal |
|----------------------------------|---|---|---|
| Level of maize offal Inclusion (%) | 0 | 25 | 50 |
| Ingredient                        |  |  |  |
| Maize                            | 50.01 | 37.51 | 25.01 |
| Maize Offal                       | 0.00 | 12.91 | 25.80 |
| Soybean Cake                     | 20.24 | 19.83 | 19.44 |
| Palmkernel Cake                  | 10.00 | 10.00 | 10.00 |
| Brewers Dried Grain              | 10.00 | 10.00 | 10.00 |
| Bone Meal                        | 3.00 | 3.00 | 2.00 |
| Oyster Shell                     | 1.00 | 1.00 | 1.00 |
| Premix (Vit-min)*                | 0.25 | 0.25 | 0.25 |
| Salt                             | 0.50 | 0.50 | 0.50 |
| TOTAL                            | 100.00 | 100.00 | 100.00 |

**Proximate Composition (% DM Basis) of diets and maize offal**

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>25</th>
<th>50</th>
<th>MO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Matter</td>
<td>88.0</td>
<td>89.00</td>
<td>88.50</td>
<td>89.70</td>
</tr>
<tr>
<td>Analyses, % of DM:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crude Protein</td>
<td>18.43</td>
<td>18.26</td>
<td>18.51</td>
<td>10.15</td>
</tr>
<tr>
<td>Crude Fibre</td>
<td>5.30</td>
<td>6.56</td>
<td>7.85</td>
<td>9.20</td>
</tr>
<tr>
<td>Ether Extract</td>
<td>7.50</td>
<td>6.48</td>
<td>6.17</td>
<td>2.60</td>
</tr>
<tr>
<td>Ash</td>
<td>5.54</td>
<td>6.70</td>
<td>7.20</td>
<td>1.50</td>
</tr>
<tr>
<td>Nitrogen Free extract</td>
<td>63.23</td>
<td>62.00</td>
<td>60.27</td>
<td>76.55</td>
</tr>
<tr>
<td>Metabolisable Energy (Kcal ME/kg)</td>
<td>3654.71</td>
<td>3383.47</td>
<td>3212.41</td>
<td>3291.86</td>
</tr>
</tbody>
</table>

*Vit A 10,000,000IU; Vit D3 2,000,000IU; Vit E8,000IU; Vit K 2,000mg; Vit B1 2,000mg; Vit B2 5,500mg; Vit B6 1,2000mg; Vit B12 2 mg; Biotin 30mg; Folic Acid 600mg; Niacin 10,000mg; Pantothenic Acid 7,000mg; Choline Chloride 500, 0mg; Vit 10,000mg; Iron 60,000mg; Mn 80,000mg; Cu 8,000mg; Zn 50,000mg; Iodine 2,000 mg; Cobalt 450 mg; Selenium 100 mg; Mg 1000,000 mg; Anti Oxidant 6,000 mg;
all faeces were pooled and analyzed for dry matter and proximate compositions. Apparent digestibilities of the nutrients were determined for the pigs.

Statistical Analyses
All the data obtained were subjected to analysis of variance and where statistical significance were observed, the means were compared using the Duncan’s Multiple Range test. The SAS Computer software package\textsuperscript{12} was used for all statistical analyses.

Results

Chemical Composition
The chemical composition of the test grower diets were shown in Table 1. The crude protein contents of the diets were slightly higher than the calculated isonitrogenous value of 18% probably due to variations in samples, though no specific trend was observed. The crude fibre and ash contents increased with increasing replacement levels of maize with maize offal (MO). The ether extract content reflected in inverse relationship with the increasing MO inclusion. A gradual decrease in the metabolisable energy content of the diets resulted with increasing MO inclusion.

Serum Metabolites
The effect of replacing graded portions of the maize component of the diet with maize offal on the serum metabolites of the growing pigs are shown in Table 2. The total protein, albumin, globulin, creatinine, urea and cholesterol concentrations in the serum of all the pigs were insignificantly (P>0.05) depressed by the increasing MO inclusion. However, the serum glucose concentration was significantly (P<0.05) depressed.

Nutrient Digestibilities
The effect of the dietary treatments on dry matter (DM) intake and nutrient digestibilities are shown in Table 3. Relative to the maize-based control diet, the DM

<p>| Table 2: Serum metabolites of growing pigs fed diets containing graded levels of maize offal as replacement for maize. |</p>
<table>
<thead>
<tr>
<th><strong>Metabolite</strong></th>
<th><strong>Level of Maize Offal Inclusion (%)</strong></th>
<th><strong>O</strong></th>
<th><strong>25</strong></th>
<th><strong>50</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Protein (g/dl)</td>
<td>6.59±0.17</td>
<td>6.66±0.15</td>
<td>4.05±0.14</td>
<td></td>
</tr>
<tr>
<td>Albumin (g/dl)</td>
<td>3.94±0.17</td>
<td>4.05±0.14</td>
<td>3.96±0.12</td>
<td></td>
</tr>
<tr>
<td>Globulin</td>
<td>2.65±0.26</td>
<td>2.61±0.21</td>
<td>2.79±0.24</td>
<td></td>
</tr>
<tr>
<td>Creatinine (mg/dl)</td>
<td>1.14±0.15</td>
<td>1.38±0.16</td>
<td>1.19±0.13</td>
<td></td>
</tr>
<tr>
<td>Urea (mg/dl)</td>
<td>27.88±2.35</td>
<td>31.00±3.07</td>
<td>30.50±1.57</td>
<td></td>
</tr>
<tr>
<td>Cholesterol (mg/dl)</td>
<td>126.37±10.96</td>
<td>128.12±7.30</td>
<td>124.12±9.08</td>
<td></td>
</tr>
<tr>
<td>Glucose (mg/dl)</td>
<td>138.87±15.86\textsuperscript{a}</td>
<td>106.12±0.4.97\textsuperscript{b}</td>
<td>99.50±0.13.80\textsuperscript{c}</td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{a, b} Means along the same row having different superscripts differ significantly (P<0.05).
intake was significantly (P>0.05) depressed by the 25 and 50% MO inclusions, though the gains of the pigs were unaffected. Both MO diets had similar (P>0.05) DM intakes. The apparent digestibilities of the crude protein, crude fibre and ether extract of the experimental diets were not different (P>0.05). The same trend was observed with the apparent digestibilities of the ash and nitrogen free extract contents.

**Discussion**

**Chemical Composition**

The increase in crude fibre contents of the diets with increasing MO inclusion could be attributed to the fibre content of the incorporated MO, as the maize-based control diet had the least crude fibre content. However, MO inclusion had an inverse relationship with the ether extract contents and the estimated ME values of the diets. The observed decrease in energy content as the fibre level in the diet increased was in agreement with the previous findings\(^4\)\(^1\)\(^3\) that inverse relationships between energy values of feedstuffs and the fibre content. The resultant energy and protein values of the diets were in the range recommended for growing pigs in the tropics\(^1\)\(^4\).

**Serum Metabolites**

The serum total protein, albumin and globulin of the growing pigs were observed to be unaffected by the MO inclusions. These parameters are indications of protein reserves in the animals\(^1\)\(^5\) and can be specifically influenced by protein shortage indicated by alterations in the albumin content\(^1\)\(^6\). The result of this study showed that the protein levels of the isonitrogenous diets were able to support normal protein reserves in the experimental pigs.

The observed values were consistent with the average values reported for normal growing pigs\(^1\)\(^1\)\(^,\)\(^1\)\(^7\). Serum creatinine and urea levels in animals are indicative of

**Table 3:** Effect of maize offal replacement of maize on feed intake and nutrient digestibilities of growing pigs.

<table>
<thead>
<tr>
<th>Metabolite</th>
<th>Level of maize offal inclusion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O</td>
</tr>
<tr>
<td>Daily Dry Matter Intake (kg)</td>
<td>1.18±0.02(^b)</td>
</tr>
<tr>
<td>Daily Weight Gain (kg)</td>
<td>0.4±10.11</td>
</tr>
<tr>
<td>Apparent Digestibilities (%) of:</td>
<td></td>
</tr>
<tr>
<td>Dry Matter</td>
<td>73.07±3.52</td>
</tr>
<tr>
<td>Crude Protein</td>
<td>61.72±8.17</td>
</tr>
<tr>
<td>Crude Fibre</td>
<td>61.51±8.21</td>
</tr>
<tr>
<td>Ether Extract</td>
<td>80.96±4.06</td>
</tr>
<tr>
<td>Ash</td>
<td>63.17±7.86</td>
</tr>
<tr>
<td>Nitrogen Free Extract</td>
<td>66.09±7.23</td>
</tr>
</tbody>
</table>

\(^a\)\(^,\)\(^b\) Means along the same row having different superscripts differ significantly (P<0.05).
muscular wastage\textsuperscript{18}. The values observed in this study were fairly constant and as such, there could not have been muscle wastage in the animals as a result of the MO inclusion at both levels. The observed values were within the range reported\textsuperscript{11}. This could have been brought about by the efficient utilization of the proteins contained in the diets thereby resulting in high tissue deposition across the groups as shown by the comparable gains.

The serum cholesterol values observed in this study were equally unaffected by the MO inclusion and were within the reported range\textsuperscript{17}. The fat content of the diets decreased with increasing crude fibre, brought about by the MO inclusion. The serum cholesterol is significantly affected by the dietary fat contrary to the present results\textsuperscript{19,20}. The decrease in serum glucose decreased with increasing crude fibre content in the diet resulting from increased MO inclusion was expected as reduction of blood glucose with high fibre diets had earlier been observed\textsuperscript{21}.

**Nutrient Digestibilities**

The increase in DM intakes of pigs fed the MO diets were normal since the incremental inclusion of the MO resulted in a dilution of the energy content of the diets and the pigs would attempt to maintain the digestible energy intake by increasing their feed intake\textsuperscript{22,23}. The addition of fibre to swine diets decreased the digestible and metabolisable energy concentrations in pig diets\textsuperscript{24,26}.

The inclusion of the MO brought about an increase in the crude fibre content of diets, but the levels were not sufficient to cause in variations in the apparent digestibilities of the nutrients. The results of this study agree with those reported earlier\textsuperscript{26,27}. However, literature contains conflicting reports about the effect of crude fibre on the digestibility of nutrients\textsuperscript{28}. It has been reported that when the source of crude fibre does not contribute significant amounts of protein in the diets, as was the case with the MO employed in this study, increased level of the crude fibre does not affect protein digestibility\textsuperscript{25,27}. In other studies, an increase in the dietary level of fibre has been observed to decreased protein digestibility\textsuperscript{30,31}. Maize Offal, being a fibre source was, therefore, expected to give bulk to the feed\textsuperscript{4} as well as to result in the reduction of the overall retention time of digesta in the gastrointestinal tract\textsuperscript{32,33}. It could, therefore, be inferred that growing pigs can tolerate up to 50% replacement of maize with MO without any adverse effect on the health status and nutrient utilization.

**References**


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RESPONSE OF LAYERS TO FEED RESTRICTION DURING THE GROWING PERIOD UNDER TROPICAL CONDITIONS

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REACTION DES PONDEUSES A LA RESTRICTION ALIMENTAIRE PENDANT LA PERIODE DE CROISSANCE SOUS LES TROPIQUES

Résumé

Quatre cent quarante-et-une poulettes de rapport âgées de 10 semaines pesant chacune 642,37 ± 26,35 g étaient utilisées pour étudier l’effet de la restriction alimentaire pendant la période de croissance sur la qualité de l’œuf et la performance de production des pondeuses de rapport. Les poules étaient réparties au hasard en trois groupes de traitement (T1, T2 et T3) de 147 poules chacun. A l’âge de 10 à 19 semaines, les poules du groupe T1 étaient nourries ad libitum, celles du T2 servies de régime réduit à 10% et celles du T3, soumises à un programme qui consistait à ne pas donner d’aliments pendant un jour, recevaient chaque fois à deux reprises le régime réduit à 10% (2 x ration T2). Même si toutes les poules expérimentales gagnaient du poids pendant la croissance, les poules du groupe T1 avaient un gain pondéral plus élevé (P < 0,01) à partir de 14 semaines et entraient en ponte 10 – 24 jours plus tôt ; en revanche le nombre de jours de ponte a diminué vers la fin et la production d’œufs était de 10% plus faible (7 - 20 jours) par rapport aux poules sous restriction alimentaire. Le taux de ponte pour les poules de T1 était plus élevé comparé aux autres au début de la ponte (19 – 23 semaines), puis ce fut l’inverse à la fin de la période de ponte (31 – 35 semaines). Cependant, pendant toute la période expérimentale, les poules sous restriction alimentaire avaient une production d’œufs beaucoup plus forte (P < 0,01) par rapport aux poules nourries ad libitum et elles ont atteint un maximum comparable au couvoir pour les poules de rapport. Par conséquent, l’alimentation ad libitum initiée a amélioré la production d’œufs, mais la restriction alimentaire s’est avérée avantageuse à la fin de la période de ponte. Toutefois, la restriction alimentaire dans des conditions d’exploitation commerciale sous les tropiques dépendra des méthodes, de la durée et des changements événuels de la qualité de l’œuf.

Summary

Four hundred and forty one 10-week old commercial pullets weighing 642,37 ± 26,35 g each were used to study the effect of physical feed restriction during the growing period on egg quality and production performance of commercial layers. The birds were randomly distributed into 3 treatment groups (T1, T2 and T3) of 147 birds each. From 10 to 19 weeks of age, birds in group T1 were fed ad libitum while T2 birds were fed 10% restricted diet each day and T3 birds placed on skip-a-day feeding program receiving twice the 10% restricted diet (2xT2 ration) each time. Although all the experimental birds gained weight similarly during growth, T1 birds showed highest (P < 0.01) weight gain from 14 weeks of age and entered laying 10 – 24 days earlier but showed decreased days to 10% egg production by 7 or 20 days than the feed restricted birds. The rate of laying for these T1 birds was higher than for the other birds at the start of laying (19 – 23 weeks) but was the reverse during the late period of the laying (31 – 35 weeks). However, over the entire experimental period only feed restricted birds showed significantly (P < 0.01) higher egg production over the fully fed birds and reached peaks comparable to the range suggested by the hatchery for commercial hens. Therefore, ad libitum feeding initiated improved egg production but feed restriction proved to be beneficial during the end-of-lay periods. However, feed restriction under commercial management conditions in the tropics will depend on the methods, duration and possible alterations in egg quality.

Keywords: Pullets, feed restriction, egg quality, egg-laying performance.

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Introduction

High feed consumption is important for increase growth rate of birds but it could result in increase fat deposition and high incidence of skeletal and metabolic disorders. Although feed is very important in commercial poultry, it is responsible for a large proportion of the production cost. Various techniques have been studied to significantly reduce nutritional diseases and production cost especially feed cost while maintaining or improving productivity. Breeding hens and pullets are normally grown on restricted diets to prevent obesity and early sexual maturity. The skip-a-day program of feed restriction is most commonly used for broiler breeders and has been reported to be superior to low protein and low lysine diets during the growing period for broiler breeders. This program gave better results than low protein or ad libitum programs in a comparison of growing programs. Increase in body weight is necessary for proper development of the reproductive system but breeders or laying hens should be allowed a modest weight gain.

Free access of pullets to food during the period of growth is known to have negative effects on egg production and performance of layers through irregular laying, production of small-sized eggs, reduce egg yield and feed wastage. In Cameroon, like many other tropical African countries, management of commercial layers are without any indications on their feed consumption before they start laying. Also, eggs produced in modern poultry farms are thought to be of inferior quality to eggs from village scavenging hens with the local reference for egg quality being size (usually 35 – 45 g), colour of the egg yolk (dark yellow) and number of eggs produced at 50-75 eggs per hen. Teguia reported higher egg production and darker yolk colour when locally produced forages (Arachis glabrata, Leucaena leucocephala, Calliandra calothyrsus and Desmodium spp) were included in layer feeds without increasing the cost of feeding or reducing the production level. The objective of the present work, therefore, was to study the effect of feed restriction during the growing period of pullets on egg quality and production of commercial layers.

Materials and Methods

Animals, diets and light programme

Four hundred and forty one 10-week old commercial pullets weighing 642.37 ± 26.35 g each were used. The birds had been vaccinated against Newcastle, Infectious Bronchitis and Infectious bursa diseases. Antistress agents were administered before and after each vaccination and after each transfer. Coccidiostats were also dispensed for 3 days per week from 15 days of age to point of lay.

All birds used in the experiment were fed ad libitum and raised on deep litter according to standard practices until 10 weeks of age. The 10-week old birds were randomly distributed into 3 treatment groups (T1, T2 and T3) of 147 birds each and maintained on deep litter. At the end of 14 weeks of age, the pullets of each group were transferred into cages and housed in pairs. From 10 to 19 weeks of age, birds in group T1 were fed ad libitum on a pellet diet made of Maize, Wheat bran, Soya bean, cotton cake meal, Bone meal and CMAV10* to meet the standard recommendation for commercial pullets feeding. The average daily feed consumption per bird in group T1 was
measured and T2 birds fed 10% restricted diet each day while birds in T3 were placed on the skip-a-day feeding program receiving twice the 10% restricted diet (2 T2 ration) each time (Table 1). Clean portable water was available to all the birds during the experiment including the feed restriction period.

In addition to natural daylight, all bird groups were subjected to additional artificial light from the onset of egg production in the T1 group as follows: 2 hours per day (5:00 – 6:00am and 18:00 – 19:00pm) for one week then 4 hours light per day (4:00 – 6:00am and 18:00 – 20:00pm) for the rest of the production period.

Collection and analysis of data

A sample of 20 randomly selected and wing banded birds from each treatment group were weighed at weekly intervals until they started laying. Sexual maturity was determined on a sample of 20 birds per treatment group using days to 10%, 50% and pick hen day production. Egg production of these birds was recorded daily as number of eggs, egg mass and egg weight and summarised weekly. Mortality was recorded daily. The data were analysed by analysis of variance (ANOVA) while significant differences between means were determined using the Duncan’s multiple range test.

Results

The influence of ad libitum feeding and feed restriction during 10 – 19 weeks of age on body weight of the commercial birds before laying is shown in Figure 1. The body weight curve of birds on 10% restricted diet (T2) and those on the skip-a-day plus restricted feeding program (T3) followed that of ad libitum (T1) until 14 weeks of age when T1 birds showed highest (P<0.01) weight gain. During the 10-19 weeks of age, the average weight at point of lay of T1 birds was significantly higher (P<0.01) 1889.5 g as compared to the other birds that weighed 1650.5 g (T2) and 1682.1 g (T3), corresponding to about 13% and 11% weight loss respectively.

The lowest mortality was observed among the feed restricted birds (Table 2). Full feeding during 10-19 weeks of age resulted in a significantly (P<0.01) higher

<table>
<thead>
<tr>
<th>Age in weeks</th>
<th>T1*</th>
<th>T2</th>
<th>T3</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>56.92</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>58</td>
<td>52.2</td>
<td>104.4</td>
</tr>
<tr>
<td>11-12</td>
<td>62.5</td>
<td>56.25</td>
<td>112.5</td>
</tr>
<tr>
<td>13-14</td>
<td>67.5</td>
<td>60.75</td>
<td>121.5</td>
</tr>
<tr>
<td>15-16</td>
<td>72</td>
<td>64.8</td>
<td>129.6</td>
</tr>
<tr>
<td>17-18</td>
<td>78</td>
<td>70.2</td>
<td>140.4</td>
</tr>
<tr>
<td>Above 19</td>
<td>Freely</td>
<td>Freely</td>
<td>Freely</td>
</tr>
</tbody>
</table>

*: Estimated consumption when fed ad libitum
death rate than the restricted birds.

Birds fed ad libitum entered laying 10-24 days earlier than birds in restricted groups and also showed decreased days to 10% egg production by 7 or 20 days (Table 2). Although the days to 50% egg production was increased for T3 birds, it was comparable between birds in groups T1 and T2.

Birds fed ad libitum laid at higher rate than that of all the restricted birds during weeks 19-23. Although the rate of lay for T3 birds was lower than the others during weeks 23-28, it was comparable to that of T2 birds but higher than that for T1 birds during weeks 31-35 (Figure 2). The pattern of distribution of egg masses during the laying period was similar to that of the rate of laying for all the treatment groups (Figures 2 and 3). Thus, when the egg production was averaged over the entire experimental period, restricted birds showed significantly (P<0.01) higher egg production over the fully fed birds. Ad libitum feeding, therefore, initiated early egg production with reduction in later periods.

For egg weights, the eggs laid by T2 and T3 birds at start of laying had comparable weights but were heavier than those of T1 birds. This pattern was maintained during the laying period but when the egg weight was averaged over weeks 19-35, the restricted birds laid heavier (P<0.01) eggs than the fully fed birds.

**Discussion**

Generally, there was little separation of body weight curves between birds in T2 and T3 during the 10 weeks feed restriction period. This suggested that approximately equal amount of feed was required to maintain the weight gain curve of T2 parallel

<table>
<thead>
<tr>
<th>Parameters</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>Reference values#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average weight of pullets at first lay</td>
<td>1889.49³</td>
<td>1650.53³</td>
<td>1682.11³</td>
<td>1700-1800</td>
</tr>
<tr>
<td>Age of pullets at first lay (days)</td>
<td>131</td>
<td>141</td>
<td>155</td>
<td>140</td>
</tr>
<tr>
<td>Age of pullets at 10% lay (days)</td>
<td>143</td>
<td>150</td>
<td>163</td>
<td>149</td>
</tr>
<tr>
<td>Age of pullets at peak of lay (days)</td>
<td>210</td>
<td>217</td>
<td>231</td>
<td>196-231</td>
</tr>
<tr>
<td>% HD at peak</td>
<td>86.6</td>
<td>94.11</td>
<td>93.27</td>
<td>91±3</td>
</tr>
<tr>
<td>Weight of egg at start of lay (g)</td>
<td>32.71</td>
<td>41.67</td>
<td>42.1</td>
<td>40-43</td>
</tr>
<tr>
<td>Average number of eggs during 19-35 weeks of age</td>
<td>64.41±33.39³</td>
<td>81.27±38.32³</td>
<td>77.31±38.89³</td>
<td>120.6</td>
</tr>
<tr>
<td>Average weight of eggs during 19-35</td>
<td>48.49±7.41³</td>
<td>50.10±6.15³</td>
<td>52.09±5.07³</td>
<td>51.89</td>
</tr>
<tr>
<td>Average mass of eggs per week (K/gweek)</td>
<td>3.34±1.90³</td>
<td>4.28±2.19³</td>
<td>4.20±2.24³</td>
<td>6.25</td>
</tr>
<tr>
<td>Mortality rate (%) during the period of layer (19-35 weeks of age)</td>
<td>15.78³</td>
<td>10.52³</td>
<td>10.52³</td>
<td>-</td>
</tr>
</tbody>
</table>

a, b: Values with same letter in row are significantly different (P>0.01)
#: Harco management guide (1999).
Table 3: Performance of commercial layers as influenced by feeding program from 10 to 19 weeks of age.

<table>
<thead>
<tr>
<th>Age in weeks</th>
<th>T1</th>
<th></th>
<th>T2</th>
<th></th>
<th>T3</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Number of eggs (per week)</td>
<td>Egg weight (g)</td>
<td>Number of eggs (per week)</td>
<td>Egg weight (g)</td>
<td>Number of eggs (per week)</td>
<td>Egg weight (g)</td>
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<tr>
<td>19</td>
<td>3</td>
<td>32.71</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>20</td>
<td>8</td>
<td>35.31</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>21</td>
<td>20</td>
<td>46.31</td>
<td>7</td>
<td>41.67</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>22</td>
<td>43</td>
<td>39.97</td>
<td>20</td>
<td>41.12</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>23</td>
<td>24</td>
<td>41.73</td>
<td>17</td>
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<td>44</td>
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<td>48.99</td>
<td>78</td>
<td>48.89</td>
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<tr>
<td>26</td>
<td>86</td>
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<td>50.04</td>
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<td>88</td>
<td>51.85</td>
<td>106</td>
<td>51.5</td>
<td>85</td>
<td>50.77</td>
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<tr>
<td>28</td>
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<td>53.65</td>
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<td>53.15</td>
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<td>53.64</td>
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<td>29</td>
<td>84</td>
<td>51.79</td>
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<td>52.25</td>
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<tr>
<td>30</td>
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<td>51.95</td>
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<td>54.31</td>
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<td>55.88</td>
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<td>35</td>
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<td>56.35</td>
<td>106</td>
<td>56.73</td>
<td>104</td>
<td>57.85</td>
</tr>
<tr>
<td>19-35</td>
<td>64.41±33.39*</td>
<td>48.49±7.41</td>
<td>81.27±38.32</td>
<td>50.10±6.15</td>
<td>77.31±38.89</td>
<td>52.09±5.07</td>
</tr>
</tbody>
</table>

*: Mean ± SD  
(-): No egg collected

Fig. 1: Body weight of commercial pullets as influenced by feeding program from 10 weeks of age to point of lay.
**Fig. 2:** Distribution of rate of lay (%HD) of commercial layers as influenced by feeding program from 10 to 19 weeks of age.

**Fig. 3:** Distribution of mass of eggs (kg) laid by commercial layers as influenced by feeding program from 10 to 19 weeks of age.
to that of T3 as birds on T1 were consuming freely.

Ad libitum feeding of growing pullets had adverse effect of layers mortality. The periods of increased ambient temperature and was probably related to increased body weight of those birds. The finding agrees with that reported earlier\(^5\).

The delay in sexual maturity observed among the feed restricted birds especially those on the skip-a-day program agrees with previous findings\(^6,7\). The positive effects of this delay in sexual maturity are evident from the peak hen-day production rates (Figure 2), number of eggs, weight of eggs (Table 3) and egg masses (Figure 3) obtained for the feed restricted birds reached a peak comparable to the range suggested by the commercial hen hatchery (Table 2).

The eggs from the T2 and T3 birds were heavier than those from full-fed layers. This was in agreement with previous report on the positive effect of restricted feeding on subsequent egg quality\(^10\).

It is concluded that ad libitum feeding of pullets during the growing period (10 – 19 weeks of age) should not be recommended. Although ad libitum feeding improved egg production initially the feed restricted birds proved to be beneficial during the end-of-lay periods and appeared to be more economical.

References


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OVIPOSITION PERFORMANCE OF ENGORGED ADULT AMBLYOMMA VARIEGATUM (FABR. 1794) FEMALE TICKS UNDER DIFFERENT RELATIVE HUMIDITY CONDITIONS.

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PERFORMANCE D'OVIPOSITION DES TIQUES FEMELLES ADULTES GORGEES AMBLYOMMA VARIEGATUM (FABR. 1794) DANS DIFFERENTES CONDITIONS D'HUMIDITE RELATIVE

Résumé

Trois différentes conditions d'humidité relative, créées suite à l'application de solutions de KCl et de NaCl, et d'eau distillée comme témoin, étaient utilisées pour étudier les périodes de préoviposition, le type d'oviposition et le nombre total d'œufs pondus par trois groupes de tiques femelles adultes gorgées Amblyomma variegatum. On a obtenu respectivement des humidités relatives de 83% ± 2,72% ± 2 et 95% ± 2 avec des solutions de KCl et NaCl saturées, et de l'eau distillée dans des dessiccateurs tout au long de l'expérience. Le nombre total d'œufs pondus par les tiques dans des conditions d'humidité relative était en moyenne de 9.655 pour KCl, 10.583 pour NaCl et 5.074 pour l'eau distillée. Les périodes de préoviposition étaient en moyenne de 11 jours pour KCl et 10 jours pour NaCl et l'eau distillée. On a enregistré des périodes d'oviposition de 28 jours pour KCl et 24 jours pour NaCl et l'eau distillée. Dans des cas de disponibilité de matériels et de performance des tiques, la solution de NaCl saturée (type hygroscopique) semblait offrir les conditions d'humidité relative les plus favorables pour la tique femelle adulte gorgée Amblyomma variegatum en ponte.

Summary

Three different relative humidity conditions, created by using saturated KCl and NaCl salt solutions and distilled water only as control, were used to study the preoviposition periods, oviposition pattern and the total number of eggs laid by three groups of engorged adult ovipositing Amblyomma variegatum female ticks. Relative humidities of 83% ± 2, 72% ± 2 and 95% ± 2 were provided using saturated KCl and NaCl solutions and distilled water only respectively in desiccators throughout the period of experiment. Total mean number of eggs laid by the ticks under relative humidity conditions created by the KCl was 9,655, 10,583 for the NaCl and 5,074 for the distilled water. The mean preoviposition periods were 11 days for the KCl and 10 days for both the NaCl and distilled water only. The oviposition periods of 28 days were recorded for KCl and 24 days for both the NaCl and distilled water only. Under conditions of ready availability of materials and performance of the ticks, the saturated NaCl (hygroscopic type) solution appeared to provide the best favourable relative humidity conditions for the engorged adult ovipositing Amblyomma variegatum female tick.

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Introduction

The establishment and maintenance of a tick colony is indispensable for tick research. Tick research in the tropics is very important in view of the abundance of different tick species infesting a host simultaneously and the differential vectorial capacities of the different tick species for transmission of various tick-borne diseases. However, only a few field and laboratory studies have been conducted in Ghana on various aspects of the biology of these tick species. This has been due to lack of facilities such as the lack of materials to be used for creation of suitable relative humidity (RH) conditions and provision of incubators for the maintenance of controlled temperature conditions to establish colonies of the different tick species.

The sustenance of a tick colony depends on the laying adult female tick. Poor laying due to unfavourable relative humidity conditions in the colony would seriously reduce the number of ticks available for research and might jeopardise the colony. In Ghana, temperatures are equable but RH changes with the seasons with low RH in the dry season and high RH during the rainfall seasons. Relative humidity and temperature are perhaps the most important environmental requirements for ticks’ survival and without suitable RH conditions, ticks succumb to desiccation and die. Yano et al reported that low RH is detrimental to earlier development of Haemaphysalis longicornis ticks. Wilson et al showed that combinations of temperature and relative humidity measured as vapour pressure deficit were strongly related to the survival of Hyalomma truncatum ticks. The creation of stable and favourable RH conditions therefore is very crucial to the sustenance and maintenance of tick colonies.

This maintenance can be achieved in the laboratory with saturated solution of certain salts. To determine the suitability of a locally available NaCl, for the creation and maintenance of stable relative humidity conditions under our conditions, an attempt was made to compare the oviposition performance of engorged female Amblyomma variegatum ticks under relative humidity conditions created by KCl, a standard material with the locally available NaCl and distilled water only as control.

Materials and Methods

Chemicals and procedures for the creation of relative humidity conditions

Potassium chloride salt was used as a standard for comparison with a locally available NaCl. The preparation of the saturated salt solutions for the creation of controlled RH conditions was according to the methods of Solomon and Winston and Bates. The crystals of the two salts were poured into separate desiccators containing water at 20°C and stirred until no more solute dissolved in the distilled water.

Three (3) desiccators; one with saturated KCl with a mean RH of 83%; another with saturated NaCl (locally-available hygroscopic type) having a mean RH of 72%; as two treatments and the third containing distilled water only with a mean RH of 95% used as control were all kept in dark cupboards with an ambient room temperature of 28°C. In the desiccators were placed a perforated either a metal plate or wooden board cut to fit the inner perimeter of the desiccator and this separated and held the tubes containing the ticks from the solution. The sitting edges of the desiccator and its lid were smeared with petroleum jelly (Blue Seal, Vaseline, Lever Bros. Ghana Ltd. Tema, Ghana). Relative
humidities of the saturated salt solutions were determined with a Branan disc hygrothermometer and the ambient room temperatures and relative humidity with a Darton hygrothermometer (Darton & Co Ltd, Watford, England) and data were recorded at the same time every week.

Tick species

Engorged adult females of *A. variegatum* tick species weighing between 1.5-3.6 g were collected from cattle in the fields at Katamanso, Ashiye, Kotoku all in the Greater Accra Region and Kasoa (15 km from Accra) in the Central Region. Each tick was cleaned with a soft, fine hair brush, put in a 1% solution of Mycostatin, an antifungal drug, dried with a blotting paper and then weighed. The Mycostatin was used to control fungal growth in the tubes containing the ticks.

Forty-five engorged female ticks were randomised into three groups with 15 ticks in each group with each group mean weight being similar. The three groups of engorged female ticks were randomly allocated to the two treatments and the distilled water only (control). Each tick in each group was then put in a sterile plain plastic tube (9.0cm by 2.4cm) with the mouth covered with muslin cloth held in place with a rubber band.

Collection and counting of eggs and weighing of ovipositing ticks

Ticks were observed daily and eggs laid by each tick were collected at two day intervals. Collection of eggs from each tube was carried out as described by Agyei (13) with the aid of a fine hair brush. Eggs were examined with an Olympus SZ 30 dissecting microscope and to estimate the large number of eggs laid, a quantity of eggs laid by each tick in a batch was counted and weighed. The number in every batch of eggs was then calculated according the method developed by Dipeolu and Ogunji (14). Laying females were weighed at the same time on each weighing day and period using a Sartorius weighing balance.

Analysis

Analysis of variance was used to determine differences in the preoviposition periods and the number of eggs laid between treatments and the control. *P*<0.05 was considered significant. Correlation analysis was used to determine the relationship between mean number of eggs laid and the mean weight changes in the adult female laying ticks.

Results

Preoviposition and oviposition periods

The preoviposition periods ranged between 9-15 days, 10-12 days and 9-12 days in the KCl, the NaCl and the distilled water only respectively. The mean number of days preoviposition were not significantly (*P*>0.05) different (Table 1). The oviposition periods in the KCl was 28 days and 24 days in both the NaCl and distilled water only (Table 1).

Number of eggs laid and pattern of oviposition

The mean total number of eggs laid in the KCl was 9,655; the NaCl, 10,583 and 5,074 in the distilled water, as shown in Table 1. Mean number of eggs laid per day was highest in the NaCl with 441, 345 for the KCl and 211 for the distilled water (Table 1). The number of eggs laid under the RH conditions of NaCl was significantly different (*P*<0.01) from those under the conditions of distilled water only but not significantly different (*P*>0.05) from the ticks under RH conditions of the KCl solution.
The highest peak of laying occurred on day 6 and this corresponded to the biggest weight change in the adult female laying ticks kept in both the NaCl and the distilled water. In the KCl group, the highest peak was from the 4th day to the 6th day, with the biggest weight loss occurring only on day 4 (Fig 1a). There was a gradual fall from day 6 to day 22 with egg laying peaking from a mean of 1,300 eggs on day 8 to a mean of 953 eggs on day 12. There was another drop in the mean number of eggs laid from day 14-16 but plateaued after day 22 (Fig. 1a).

In the NaCl group, the mean number of eggs laid increased from 867 eggs on day 4 to 2426 eggs on day 6, followed by a rapid decline to 1,213 eggs, exactly 50% on the 8th day (Fig. 1b). Thereafter, there were fluctuations in the mean number of eggs laid, until egg laying stopped with a mean number of 91 eggs on day 24 (Fig. 1b).

The distilled water group behaved similarly like those in NaCl group except for the mean number of eggs laid and the fewer

Fig. 1 shows the egg laying pattern and weight changes in engorged adult females of *Amblyomma variegatum* ticks under relative humidities created by (a) saturated KCl solution, (b) saturated NaCl solution and (c) distilled water.

<table>
<thead>
<tr>
<th>Solution</th>
<th>Total No. of eggs</th>
<th>Mean number of eggs laid per day</th>
<th>Mean Pre-oviposition period (Range)</th>
<th>Total number of peaks of egg laying</th>
<th>Highest peak day of laying (days)</th>
<th>Peak of weight loss</th>
<th>Total number of days of laying</th>
</tr>
</thead>
<tbody>
<tr>
<td>KCl</td>
<td>9,655</td>
<td>345</td>
<td>11 (9-15)</td>
<td>2</td>
<td>4-6</td>
<td>4</td>
<td>28</td>
</tr>
<tr>
<td>NaCl</td>
<td>10,583</td>
<td>441</td>
<td>10 (10-12)</td>
<td>4</td>
<td>6</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>H2O (distilled)</td>
<td>5,074</td>
<td>211</td>
<td>10 (9-12)</td>
<td>3</td>
<td>6</td>
<td>6</td>
<td>24</td>
</tr>
</tbody>
</table>

Table 1: Preoviposition and oviposition characteristics of *A. variegatum* tick species in different humidities created by different salt solutions and distilled water only.
peak periods of egg laying. Most of the eggs were, however, found to be wet and the eggs appeared fully immersed in the accumulated water of condensation in the tubes. After the peak of 1,127 eggs on the 6th day, a drastic fall to a mean number of 520 eggs (48%) on day 10 (Fig. 1c) occurred with as low as a mean number of 40 eggs laid on day 24. There was positive correlation between the number of eggs laid and loss in mean tick weights as shown by $r = 0.533$ for KCl, $r = 0.425$ for NaCl and $r = 0.786$ for the distilled water control (Fig. 1a, b and c).

**Discussion**

The findings of a lower RH from the two salts compared to the distilled water only showed that the RH from the salts differed from that of distilled water only. It was observed that the performance of the ticks under the humidity conditions created by both the KCl and NaCl in terms of the number of eggs laid were not significantly different ($P>0.5$). Studies on the life cycle of *Amblyomma variegatum* tick species have shown broad ranges of preoviposition periods of 5-14 days at 28°C and an RH of 80-95% 15. Andreasen 16 reported the highest limits of 21-35 days of preoviposition at a temperature of 27±1°C and RH of 85±1% which is different from the ranges of 9-15 days in all the solutions reported in this study. Hoogstraal17 gave a mean of 12 days at a temperature range between 25-27°C and under an unspecified RH. The results of the present work of 9-15, 10-12 and 9-12 days in KCl solution, NaCl solution and distilled water respectively is in line with those of Hoogstraal17. The differences in the ranges of the preoviposition periods recorded by Andreasen16 could be attributed to the different temperatures and relative humidities employed, and probably the use of different hosts 14, 18. The poor performance of ticks with the low number of eggs laid under the distilled water only conditions could be related to the accumulation of water in the tubes as a result of condensation of water vapour which led to the ticks appearing to be drowned. Krober and Guerin 19 have shown that ticks are hydrophobic and avoid direct contact with liquid water. The absence of liquid water in the tubes kept in desiccators with the salts indicate that they are able to prevent such condensation to occur and that the salt is important in creating the required stable relative humidity conditions. Wilson et al. 10 showed that certain combinations of different temperatures and relative humidities were strongly related to the survival of ticks and this was independent of the weight or sex of the tick. Hafez and Bishara 20 also reported that ticks showed rapid fall in weight and high mortality when maintained under conditions of low relative humidity but under high relative humidity conditions of 90%, weight loss was gradual and no mortality occurred. The positive correlation between the mean number of eggs laid and the loss in mean tick weight with all the three groups of ticks in all the two treatments and the control indicates that the bulk of the weight loss was due to the egg laying. Ticks in that stage are in a very low state of metabolic activity 21 and show very minimal use of its body resources for other physiological activities apart from oviposition. It is known that the main objective of feeding in the adult female tick is to lay eggs and die 22.

The number of eggs produced by the ovipositing ticks under the relative humidity conditions of the saturated NaCl solution were not significantly different ($P<0.05$) from those of the KCl solution which is a standard material 12 indicating that the locally
available NaCl is probably equally good in creating a favourable RH environment for the production of tick eggs. El Shoura and Shoura El showed that in all the temperature and relative humidity combinations made, Ornithodorus erraticus ticks survived best in a combination of 28°C and a RH of 75%. The laying pattern in NaCl solution appeared closer to that obtained by Dipolu and Ogunji. The use of KCl was due to the fact that it has been established by Winston and Bates that it can maintain stable RH conditions. It was observed that though distilled water only created RH of 95% higher than that of NaCl, it had an adverse effect on the ticks performance as result of the condensation of its water vapour. This has made water only an unsuitable material for creating suitable conditions for the maintenance of ticks under colony conditions. The results of this work suggest that the locally-available NaCl (hygroscopic type) which is more readily available and cheaper than KCl would be useful for the creation and maintenance of suitable relative humidity in Amblyomma variegatum tick colonies under our conditions.

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References


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References

SHORT COMMUNICATION

GENITAL LESIONS ASSOCIATED WITH TRYPANOSOMA VIVAX AND TRYPANOSOMA CONGOLENSE INFECTIONS IN ZEBU / FRIESIAN CROSSBRED BULLS.

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Pathogenic animal trypanosomes are protozoal haemoparasites that have been reported to cause testicular degeneration in laboratory animals and ruminants. Genital degeneration in animals can result in deterioration of semen characteristics or cessation of spermatogenesis. A detailed work on the pathogenic effect of trypanosomosis on the male genitalia of pure breed zebu cattle in Nigeria was reported by Sekoni et al. The main objective of this investigation was to carry out a study of the pathogenic effects of T. vivax and T. congolense infections on the male genitalia of Zebu / Friesian crossbred bulls.

Six normal healthy Zebu / Friesian crossbred bulls aged between 3 and 5 years were used. Palpation of the external and internal genitalia of the bulls revealed normal anatomical structures. The bulls were housed individually in fly-proof accommodation throughout the investigation. They were fed with concentrates, fresh pasture, hay, silage, salt licks and water ad libitum.

The bulls were separated into three groups of two animals each. The three groups were kept in the same building but in different fly proof rooms, completely partitioned from each other to prevent mixed infections. Groups 1 and 2 were infected with Y 58 strain of T. vivax and 2295 of T. congolense respectively, while group 3 served as uninfected control. The strains which were isolated from natural infections in cattle in Northern Nigeria, were used to infect the bulls. The stabilates had been inoculated into mice and then transferred into goats. Two ml of blood containing approximately $2 \times 10^6$ trypanosomes from the infected goats were inoculated intravenously (i.v.) into each bull. Parameters monitored twice weekly post-infection were rectal temperatures, packed cell volume, haemoglobin and total plasma proteins. Measurement of scrotal circumference, palpation of the scrotal contents and internal genitalia (via the rectum) was carried out weekly.

The infected and control bulls were slaughtered at the twelfth (12th) week of the study. Samples for histopathological studies were taken from the testes, epididymides, seminal vesicle, prostate gland, ampullae, pelvic urethra and penis following gross examination of the organs. Tissues taken at necropsy were fixed in Bouin’s solution for histopathology for 72 hours. They were stained with haematoxylin and eosin (H&E), periodic acid schiff (PAS) and Van Giesson (VG). The presence and conditions of the germinal epithelial and Sertoli cells were examined microscopically.

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All the bulls infected with *T. vivax* and *T. congoense* developed chronic trypanosomosis and were all positive for trypanosomes within 8 days of infection. Clinical signs which were more pronounced in the *T. congoense* infected bulls included fluctuating pyrexia (105-106°F), rapid weight loss, lethargy, weakness, dull and rough hair coats, pale mucous membranes, enlarged superficial lymph nodes and anaemia.

The testes, epididymides, epididymal sperm reserve (100%), seminal vesicles, prostate glands, ampullae, urethra, penis, glans penis and prepuce of the control bulls were normal. All the *T. vivax* infected bulls had severe testicular degeneration. Trypanosomosis caused sloughing and disruption of all the cellular structures in the interstitial tissue and seminiferous tubules (Fig.1), resulting in depletion of epididymal sperm reserve and moderate degeneration of the seminal vesicles, prostate gland, and ampullae. No lesions were present in Cowper’s glands, urethra and penis. All the *T. congoense* infected bulls had severe testicular degeneration with collapsed tubules. The architecture and the cellular components of the seminiferous tubules and the interstitial tissue were collapsed. The observed lesions were more severe in the *T. congoense* infected bulls than the *T. vivax* infected bulls. Similarly, epididymal degeneration was more marked in the *T. congoense* infected animals (Fig.2). All bulls had severe epididymal degeneration with total depletion of epididymal sperm reserve. Degenerative changes in the seminal vesicles and prostate glands were severe and more marked in the *T. congoense* infected bulls. One bull had moderate degeneration of the ampullae. No lesions were present in Cowper’s gland, urethra, penis, and prepuce of any of the bulls.

The results demonstrated very clearly that trypanosomosis had a very devastating effect on the male genitalia. *T. congoense* was associated with more severe genital lesions than *T. vivax*. Also for all the parameters studied, *T. congoense* was more pathogenic in contrast to earlier observations in West Africa where the latter was found to be more pathogenic. The pathogenic effects of trypanosomosis on the male genitalia as recorded in this study

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**Fig. 1.** Severely degenerated testis of a Zebu x Friesian crossbred bull infected with *T. vivax* and slaughtered 12 weeks p.i. Note the sloughing of the seminiferous tubular epithelium and disrupted spermatogenesis (H & E, x 200).

**Fig. 2.** Severely degenerated epididymis of a Zebu x Friesian crossbred bull infected with *T. congoense* which died at 8 weeks p.i. Note the destruction of tubules and the lack of epididymal sperm reserve (H & E x 400).
were more severe than those reported in purebred Zebu bulls infected with similar strains of trypanosomes. These findings suggest that there may be a breed effect that influences the pathogenesis of trypanosomosis in animals.

The most severe lesions in this study were in the testes and epididymides. The total depletion of the epididymal sperm reserve was most likely a consequence of the stoppage of sperm production due to the impairment of spermatogenesis. Some of the possible mechanisms of tissue and organ damage and destruction responsible for the severe lesions observed in the testes, epididymides and accessory male genitalia have been discussed by many investigators. Severe testicular lesions as observed in this investigation could also be partly due to the fluctuating, intermittent pyrexia that accompanied several parasitaemic peaks following infection.

This study clearly demonstrates that pathogenic animal trypanosomes may be important causes of infertility or sterility in Zebu x Friesian crossbred bulls and it also shows that the crossbred bulls are more susceptible than the purebred indigenous Zebu bulls in Nigeria. To prevent or ameliorate the untoward consequences of trypanosomosis, crossbred bulls should be closely monitored, managed with adequate veterinary care. In conclusion, pathogenic animal trypanosomes such as *T. vivax* and *T. congoense* could be economically important as causes of infertility or sterility in Zebu / Friesian crossbred bulls in trypanosomosis endemic areas of sub-Saharan Africa.

References


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SHORT COMMUNICATION

PREVALENCE OF COCCIDIOSIS IN SHEEP FLOCKS IN VILLAGES IN THE GA RURAL DISTRICT OF GHANA


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A survey of ovine coccidia was conducted in three (3) villages in the Ga Rural district, during 3 months (June - August) of the rainy season. In all, a total of 120 samples were examined. *Eimeria* oocysts were found in all samples. Five species of *Eimeria* (*E. parva, E. arloingi, E. intricata, E. faurei* and *E. pallida*) were identified. Mixed infections predominated (98.3%) with *E. pallida* being the only species associated with pure infections. *Eimeria* oocysts counts were not significantly affected (P > 0.05) by the village where the sample was taken or the age group of sheep from which it was taken. The results of the study showed that coccidia infection was not uncommon in the Ga Rural district. Though oocyst counts were low (subclinical conditions), coccidiosis could still cause inapparent economic losses, particularly when nutrition is inadequate.

The increase in animal numbers, and therefore supply of meat and meat products, has not been able to keep pace with the rapid increase in the Ghanaian population (3.2% per annum)1. As a result animal protein intake of the average Ghanaian is 13.5g per day per person2 which is below the world average of 24.8 g day1(2). It is therefore becoming increasingly necessary to critically assess the factors that cause depression in animal production.

Field reports in Ghana show that parasites, particularly gastro-intestinal protozoa of the genus *Eimeria* are among the causes of disease in our livestock3. Immunological studies4 and species identification5 of *Eimeria* have been carried out.

Losses due to *Eimeria* infections elsewhere have been well documented6,7,8,9,10. The parasite multiplies in the mucosa of the intestinal canal following ingestion of the oocyst. After a short incubation period, there is a bloody diarrhoea, rapid loss of weight and anaemia11. The infection may be fatal in acute or severe cases and at subclinical levels the health status of infected animals is impaired for a period of time7,12,13.

This paper is a report on a preliminary survey of sheep in the Ga Rural District, to ascertain the prevalence of *Eimeria* and also to identify the particular species of *Eimeria* that are present, under the prevailing management practices.

Three (3) villages were selected at random in the Ga Rural District. Forty (40) sheep were sampled from each of the three villages. The sampling was done according to age groups (ewes, gimmers, young rams and lambs) with 10 sheep in each group. Faecal samples were taken from the rectum of sheep over a 3-month period (June-August) during the rainy season. Each sheep was sampled once.

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Three grams of faecal pellets were crushed, mixed with potassium dichromate solution and strained to remove large debris. The sediment was then filtered through absorbent gauze and incubated overnight in a Baerman funnel fitted with rubber tubing and clamped. Oocysts were recovered using the salt flotation technique\(^7\). Oocysts, so obtained, were examined microscopically using the MacMaster counting technique and detailed morphological descriptions were recorded. Identification of oocysts was based on colour and morphological features of the species as described by MAFF\(^{14}\). The total count was taken as the sum of the counts of all the species present in a particular sample. Counts of the various species per sample were also used to establish a scoring system.

A score of 5 was given for the predominant species in each sample with the next in importance getting a score of 4 and so on. A total score for each species was calculated.

The statistical model aimed to find out whether the log-transformed total oocyst count was influenced by either the village where the sample was taken or the age group of the animal from which it was taken. The model was, therefore, as follows:

\[
Y_{ij} = \mu + V_i + C_j + e_{ij}
\]

Where:
- \(Y_{ij}\) = log-transformed oocyst count
- \(\mu\) = Overall mean
- \(V_i\) = effect of \(i\)th village
- \(C_j\) = effect of \(j\)th age group of sheep
- \(e_{ij}\) = a random error associated with each observation.

Statistical analysis was carried out using the statistical package of the Statistical Analysis Systems Institute\(^{15}\).

All samples examined were infected with *Eimeria* oocysts. Table 1 shows the least square means of oocyst counts for the various villages and age groups of sheep. Neither the village where the

<table>
<thead>
<tr>
<th>Village</th>
<th>Mean Oocyst Count</th>
<th>10-Transformed Mean Oocyst Count</th>
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</thead>
<tbody>
<tr>
<td>Ablajei</td>
<td>2.58 ± 0.237</td>
<td>380</td>
</tr>
<tr>
<td>Medie</td>
<td>2.48 ± 0.135</td>
<td>300</td>
</tr>
<tr>
<td>Samsam</td>
<td>2.45 ± 0.192</td>
<td>282</td>
</tr>
</tbody>
</table>

**Age group**

<table>
<thead>
<tr>
<th>Age group</th>
<th>Mean Oocyst Count</th>
<th>10-Transformed Mean Oocyst Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gimmer</td>
<td>2.71 ± 0.174</td>
<td>510</td>
</tr>
<tr>
<td>Young ram</td>
<td>2.58 ± 0.242</td>
<td>381</td>
</tr>
<tr>
<td>Lamb</td>
<td>2.54 ± 0.271</td>
<td>347</td>
</tr>
<tr>
<td>Ewe</td>
<td>2.18 ± 0.165</td>
<td>152</td>
</tr>
</tbody>
</table>

\(^1\)-Antilog of log mean oocyst count
Fig. 1. Percentage incidence of Eimeria species in samples examined

Fig. 2. Total score for various Eimeria species
sample was taken nor the age group of sheep from which it was taken had a significant effect (P>0.05) on the log-transformed oocyst count. Oocyst counts were highest in Ablajei village (380) followed by Medie village (300) and finally Samsam village (282). Gimmers had the highest oocyst count (510) followed by young rams (381), lambs (347) and ewes (152), in that order. Five species of *Eimeria* were identified. These were *E. arlongi, E. parva, E. faurei, E. pallida* and *E. intricata*. Mixed infections dominated (98.3%), with *E. pallida* being the only species isolated from the samples as pure infection. The occurrence of the species of *Eimeria* in the samples is shown in Fig. 1. *E. pallida* was found in 80.0% of the samples examined, *E. parva* (61.7%), *E. arlongi* (55.0%), *E. faurei* (43.3%) and *E. intricata* (5.0%). Total score for each species, presented in Fig. 2, followed a similar pattern.

The mixed coccidial infections observed in this study agrees with the findings of others\(^5,10,16\) who have also indicated that naturally acquired infections of coccidiosis in sheep are composed of a number of different species of *Eimeria*. The high prevalence of coccidia oocysts in the faecal samples indicates that infection with *Eimeria* species is not uncommon in the Ga Rural District. It has been observed that coccidiosis is one of the major causes of lamb mortality in the Accra Plains, within which the study area is located, and that *Eimeria* are the first parasites to colonise the gastro-intestinal tract of lambs\(^17\). All the sheep sampled did not show any apparent clinical symptoms and their conditions could be described as subclinical coccidiosis. Coccidial egg counts ranged from 20 to 3,6000 oocyst g\(^{-1}\) and is less than the 5000 oocyst g\(^{-1}\) which has been described as the threshold for clinical signs to occur\(^18,19\). The low counts obtained in this study could be explained by the semi-intensive and free-range farming systems in the Ga Rural District. It has been reported\(^9,13\) that coccidiosis is a major cause of diarrhoea in intensively kept (housed) sheep. *E. pallida* was considered to be the most important species in the study area as it had the highest total score (440) as well as being the most prevalent (80.8%). Though *Eimeria* oocysts counts were found to be low, subclinical conditions may cause inapparent economic losses, particularly when nutrition is inadequate.

**References**

animals (7th edition), Bailliere Tindall, London: 809.


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The mixed coxalcoelid infections observed in this study agree with the findings of others who have also indicated that naturally obtained infections of coxocercosis in sheep are characterized by a number of different species of Echinota. The high prevalence of parasitic infections in the Flavaculina nymphalis indicates that infections with Echinota species are not uncommon in the Oya Rural District. It was also observed that coxocercosis is one of the major causes of lambs mortality in the district, within which the study area is located, and that Echinota species are the host parasiites to which the affected animal's host. All the sheep infected did not show any specific clinical symptoms and their condition could be described as subclinical condition. Coccidial egg counts ranged from 20 to 3,980,000/gram of the examined faeces. As a result, the infection is widespread and often unnoticed.

References

SHORT COMMUNICATION

ABNORMALITIES OF EXTERNAL GENITALIA OF BUCKS AND RAMS (SMALL RUMINANTS) IN SOKOTO AND ITS ENVIRONS

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Nigeria is a country blessed with immense material resources. Part of the material resources is the abundant livestock population of which sheep and goats contribute 13 million and 26 million respectively\(^1\). Small ruminants are important domestic animals in tropical livestock production system\(^2\). Small ruminants play an important role in the economy of many countries including Nigeria. The economic importance of small ruminants depends on the value of their produce or services which include among others meat, fibres and skin. Meat and milk obtained from these animals constitute the major sources of animal protein for a greater part of the population\(^2\). Hides, skin and bone which are by-products of these animals serve as raw materials for some agro-based industries, thereby serving as a source of scarce foreign exchange\(^3\). Manure from these small ruminants is also used to nourish the soil to improve growth.

There is the need for the promotion of goats and sheep production because human populations are growing very rapidly thereby creating a significant and increasing demand for additional animal protein food\(^2\). The incidence of abnormalities of external genitalia is likely to negate the effort to increase the production of this vital source of animal protein to the populace. It is obvious that animals with these abnormalities of the external genitalia such as cryptorchidism, testicular hypoplasia, orchitis and paraphimosis cannot reproduce effectively. The aim of this study was to determine the prevalence of these conditions in this locality and discuss its implication on the reproductive capabilities of these animals as well as proffering solutions on how the conditions could be prevented.

The 2,060 bucks and 1,020 rams of Sokoto red and Oudah breeds respectively were examined at the Sokoto metropolitan abattoir, Kara (goat market in Sokoto metropolis), individual farms and homes at Achida, Dundaye, Mure, Dange, Shuni Bodinga, Shagari and Yabo (all within the outskirts of Sokoto). The bucks and rams examined were within the ages of 9 – 24 months. The ages of the animals were determined using dentition method\(^4\). Detection of non-descent of one or both testes, as well as testicular hypoplasia was done by scrotal palpation\(^5,6\). In cryptorchidism, the scrotal pouch is usually devoid of testicles. In testicular hypoplasia, the affected testicles are freely mobile within the tunica vaginalis but they are usually small and flabby on palpation. The epididymis is small and hard. Paraphimosis was visually detected.

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The results of this study showed that out of the 2,060 bucks examined, 39 (1.75%) had various forms of abnormalities of the external genitalia. Breakdown of the results showed that out of the 39, 20 (0.97%), 6 (0.29%) and 10 (0.49%) had testicular hypoplasia, cryptorchidism and and paraphimosis respectively. Further breakdown of the results showed that out of the 20 cases of testicular hypoplasia, 6 (30%) and 9 (45%) affected the right and left testicles respectively while 5 (25%) was bilateral. Further breakdown of the results also showed that out of the 6 cases of cryptorchidism, 3 (50%) affected the right and left testicles each. The results of the study also showed that out of the 1,020 rams examined, 19 (1.87%) had two forms of abnormalities of external genitalia. Breakdown of the results showed that 17 (1.67%) and 2 (0.20%) had testicular hypoplasia and orchitis respectively. Further breakdown of the results showed that out of 17 cases of testicular hypoplasia 5 (29.41%) and 12 (70.59%) affected the right and left testicles respectively. The two cases of orchitis were bilateral.

The results of this study showed that abnormalities of external genitalia occurs in Sokoto red bucks and Oudah rams in Sokoto and its environs. The abnormalities observed included testicular hypoplasia, cryptorchidism, paraphimosis and orchitis.

Testicular hypoplasia implies an incomplete development of germinative layers of the seminiferous tubules. This condition is characterized by abnormal reduced size of testicles due to hereditary cause. This condition was the most prevalent condition of the testes encountered during this study.

The prevalence of testicular hypoplasia recorded in this study is much lower than the 55.60% reported in a study conducted in Ibadan (Nigeria). Cases of testicular hypoplasia vary in severity from those that show only poor spermatozoa concentration and defective morphology to others in which there is complete aspermia. One or both gonads may be affected. In this study, testicular hypoplasia affected the left testes more than the right similar to earlier observation. Owing to the hereditary nature of the condition, prevention is by culling the ailing male to avoid propagation of the hereditary defects in goat and sheep population.

In ruminants, there is a possible association of the polled character with testicular retention and reports of incidence of cryptorchidism in small ruminants is scanty. This is a reflection of the neglect which these two species suffer in the area of scientific research in the tropics and subtropics. In this study, 29 cases of cryptorchidism were recorded in bucks and none in rams. The right and left testes were equally affected as observed earlier. The absence of cryptorchid ram is in agreement with past observation observed that cryptorchidism is uncommon in rams. The condition could be unilateral or bilateral. However, we observed only unilateral cases in this study. Abdominal retention of testes is associated with aspermia and consequently when both testes are retained, the animal is sterile. This is as a result of high abdominal temperature on the germinal epithelium of the seminiferous tubules. Since the condition is often hereditary, the remedy would be culling all affected animals as demonstrated by Warwick, who reported that strong selection pressure over the course of 20 years reduced the prevalence of cryptorchidism from 50% to 0.8%.

Paraphimosis denotes inability of males to withdraw the penis into the prepuce after protrusion. This condition may be caused by either due to an after
effect of penile erection through a stenotic preputial ring or due to spinal disease. The pathological condition of this condition cause disturbances of normal physiological function of penis and prepuce. The affected genitalia exhibits local edema and pain. This condition could lead to impotential coeundi due to inability to copulate.

In this study, 0.20% of orchitis was observed in rams and none in bucks and they were bilateral. The prevalence of orchitis in rams only could be due to the pendulous nature of the scrotum which makes it prone to trauma. However, as trauma is the most common cause of the condition, sources of trauma to the animal should be eliminated.

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, Organisation de l'Unité Africaine/Bureau interafricain des Ressources animales, P.O. Box 30786, Nairobi, Kenya.


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

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).

Brève communication
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).

Tirés à part
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 $EU.

Abonnements
le coût de l'abonnement annuel y compris le tarif d'affranchissement (par voie terrestre) et le frais de manutention, est de 50 $EU. 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.