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

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Two copies of articles should be sent to the Editor, Organisation of African Unity/Interafrican Bureau for Animal Resources, P.O. Box 30786, Nairobi, Kenya.
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Introduction stating the purpose of the work.
Materials and Methods regular.
Results regular.
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THE PREVALENCE OF GASTROINTESTINAL PARASITES IN COMMERCIAL PIG FARMS IN THIKA DISTRICT, KENYA

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LA PREVALENCE DES PARASITES GASTRO-INTESTINAUX DANS LES EXPLOITATIONS PORCINES COMMERCIALES DANS LE DISTRICT DE THIKA AU KENYA

Résumé

Une étude transversale a été menée afin de déterminer la prévalence des parasites gastro-intestinaux dans 35 exploitations porcines commerciales dans le district de Thika au Kenya. Des prélèvements fécaux ont été recueillis de 830 porcs de tous les groupes d'âge et examinés pour évaluer le nombre d'œufs de vers par gramme de fèces (OPG) en utilisant une technique modifiée de McMaster avec un niveau minimum de détection de 100 OPG. Au moins une espèce de nématode était présente dans 94% des exploitations porcines. Oesophagostomum spp., Ascaris suum, Trichuris suis et Strongyloides ransomi étaient les seuls nématodes dépistés (prévalences de 27,6%, 8,3%, 6,8% et 2,3% respectivement). Oesophagostomum spp. était le plus prévalent chez les truieaux (88,6%). Oesophagostomum spp. avait la plus forte prévalence chez les adultes (44%) ; A. suum et T. suis étaient plus prévalents chez les porcelets sevrés (14,3% et 16% respectivement) tandis que S. ransomi était plus prévalent chez les porcelets (10%). Les porcots, les porc à baeon et les adultes n'étaient pas infectés avec S. ransomi. Il y avait une large répartition de tous les parasites.

Summary

Across-sectional study was carried out to determine the prevalence of gastrointestinal parasites in 35 commercial pig farms in Thika district, Central Kenya. Faecal samples were collected from 830 pigs of all age groups and examined for eggs per gram (EPG) of faeces using a modified McMaster technique with a minimum detection level of 100 EPG. Ninety four percent of the farms carried at least one nematode genus. Oesophagostomum spp., Ascaris suum, Trichuris suis and Strongyloides ransomi were the only nematodes detected (prevalences 27.6%, 8.3%, 6.8% and 2.3%, respectively). Oesophagostomum spp. were the most prevalent among the herds (88.6%). Oesophagostomum spp. had the highest prevalence in the adults (44%), A. suum and T. suis were most prevalent in the weaners (14.3% and 16%, respectively), and S. ransomi was most prevalent in piglets (10%). The porkers, baconers and adults were not infected with S. ransomi. The distributions of all the parasites were overdispersed.

Introduction

Gastro-intestinal (GI) parasites limit pig production. The direct losses caused by these parasites are attributed to acute illness and death, premature slaughter and rejection of some parts at meat inspection. Indirect losses include the diminution of productive potential such as decreased growth rate, weight loss in sows and reduction in litter size.

A number of surveys have been done elsewhere to determine the prevalence of GI parasites in pigs and results have shown that the most common nematode parasites responsible for causing various losses to pig farming include O. dentatum, O. quadrirspinulatum, A. suum.

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T. suis and Hyostrongylus rubidus. However, few studies have been undertaken on the prevalence of pig GI nematodes in Kenya. An abattoir survey by Langai showed that strongyles, A. suum, T. suis and coccidia were prevalent in slaughter pigs in Kenya.

Currently, there is no information on the prevalence of coccidial parasites in Kenyan pigs. In North America, coccidiosis is a disease of neonatal pigs with older pigs being carriers. The disease, caused mainly by Isospora suis, is found in all types of management systems and is responsible for 15-20\% of cases of piglet diarrhoea seen at diagnostic laboratories in USA, Canada and other countries.

A study was designed to determine the prevalence of GI infections in pigs in commercial pig farms in Thika district (a leader district in pig production in Kenya).

Materials and Methods

Location

The study was conducted on commercial pig herds in Thika district during the period of November 1999 to February 2000. The district is located in the southern part of the Central province of Kenya at latitudes 1.45°S-3.53°S and longitudes 36.35°E-37.25°E. The mean temperature of the district ranges between 14°C in the cooler highland zones to 22°C in the dry lowland zones. The annual rainfall which is bimodal varies from 500 mm to 1500 mm depending on the altitude.

Farms and animals

The farms used in this study belonged to farmers who supplied their animals to one abattoir, which processes 70-80\% of the pigs produced in Kenya. A total of 830 pigs from 35 large farms were used in the study. The study herd selection was carried out in collaboration and with the help of field procurement officers from the abattoir who regularly visit the farms. During the selection process every large farm in the district was included in the survey. The criterion of choosing the farms was that they should have a minimum of 25 pigs of all age groups per herd. However, 8 farms included in this study did not have piglets. No formal procedure to secure representativeness of the pig herds in all the administrative and geographical areas could be implemented since the herds were evenly distributed across the district.

Sampling

During each of the visit to the 35 piggeries, faecal samples were collected from five randomly selected pigs in each of the 5 classes of pigs: piglets (0-8 weeks), weaners (weaning to 10 weeks), young pigs (11-16 weeks), baconers (17-28 weeks) and adults (mated gilts and sows). The animals sampled had not been treated with any anthelmintic at least during the previous 4 weeks.

The faecal samples were collected per rectum with a new, unused glove for each pig, put into faecal pots which were labeled and kept cool prior to transportation to the laboratory where they were immediately examined or stored at refrigeration temperature (4°C) for a maximum of 1 day before processing. Eggs per gram (EPG) were quantified using a modified McMaster technique. The presence of coccidial oocysts was recorded. Larval cultures for samples containing strongyle eggs were used for species differentiation.

Statistical analysis

Data was analyzed using the statistical software programme Statistix® Version 4.0. Prevalence of each species was calculated (both herd-level and pig-level)
**Tabel 1. Infection with different nematodes species among the 35 herds sampled during the study**

<table>
<thead>
<tr>
<th>Parasite</th>
<th>Herds infected</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>All nematodes</td>
<td>33</td>
<td>94</td>
</tr>
<tr>
<td><em>Oesophagostomum</em> spp.</td>
<td>31</td>
<td>89</td>
</tr>
<tr>
<td><em>Ascaris suum</em></td>
<td>16</td>
<td>46</td>
</tr>
<tr>
<td><em>Trichuris suis</em></td>
<td>18</td>
<td>51</td>
</tr>
<tr>
<td><em>Strongyloides ransomi</em></td>
<td>7</td>
<td>20</td>
</tr>
</tbody>
</table>

according to Thrushfield. 95% confidence intervals were also calculated. Prevalences in different age groups were compared using the chi-squared ($X^2$) test using the Epi info 6 package.

**Results**

**Nematode infections**

In total, 33 (94%) farms had at least one nematode species (Table 1). Most farms had *Oesophagostomum* spp. and *T. suis* infections. Seventy seven percent of the farms sampled had adult pigs infected with *Oesophagostomum* spp. (Table 2). In most farms, *T. suis* was found mainly among the weaners and porkers while *S. ransomi* was found in very few farms affecting mainly the piglets and weaners.

A total of 325 (39%) the pigs were infected by different nematodes. The majority (27.6%) of these were infected with *Oesophagostomum* spp (Table 3). In descending order other animals infected included: 8.3% with *A. suum*, 6.8% with *T. suis* and 2.3% with *S. ransomi*. The prevalence of infection varied among the different ages of sampled animals. In descending order, *Oesophagostomum* spp. mainly infected the adult animals, baconers, porkers, weaners and piglets. The prevalence of *A. suum* infection was significantly higher ($p<0.05$) in weaners followed by baconers, porkers, adults and piglets. For *T. suis*, the weaners were the

**Tabel 2. Prevalence of different nematode species in 35 piggeries studied**

<table>
<thead>
<tr>
<th>Animal</th>
<th><em>Oesophagostomum</em> spp.</th>
<th><em>Ascaris suum</em></th>
<th><em>Trichuris suis</em></th>
<th><em>Strongyloides ransomi</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Piglets</td>
<td>12</td>
<td>4</td>
<td>12</td>
<td>19</td>
</tr>
<tr>
<td>Weaners</td>
<td>54</td>
<td>40</td>
<td>37</td>
<td>9</td>
</tr>
<tr>
<td>Porkers</td>
<td>57</td>
<td>14</td>
<td>26</td>
<td>0</td>
</tr>
<tr>
<td>Baconers</td>
<td>54</td>
<td>20</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Adults</td>
<td>77</td>
<td>20</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>
most affected (prevalence, 16%). Infection by this worm was significantly (p<0.05) lower in adults as compared to either weaners or baconers. The prevalence of *S. ransomi* was highest in piglets. The adults and porkers were affected by this parasite.

Of the sampled animals, 22% were infected with *Oesophagostomum spp.* alone. Monoinfections also were observed for *A. suum, T. suis* and *S. ransomi.* The most common combination of nematodes was that of *Oesophagostomum spp.* and *A. suum* (3%). There was no animal infected by all the four nematodes. Most of the farms (23%) had monoinfections of *Oesophagostomum spp.* and 9% were infected by *T. suis* alone.

The only nematodes whose egg exceeded 5000 (in some animals) were *T. suis* and *A. suum* (Table 4). For all species, most of the eggs were detected in only a

**Table 3. Prevalence of nematode infection in the 830 animals sampled during the study**

<table>
<thead>
<tr>
<th>Animal</th>
<th>Number of Pigs tested</th>
<th>Percentage positive</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><em>Oesophagostomum spp</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td>%</td>
</tr>
<tr>
<td>Piglets</td>
<td>130</td>
<td>5</td>
</tr>
<tr>
<td>Weaners</td>
<td>175</td>
<td>25</td>
</tr>
<tr>
<td>Porkers</td>
<td>175</td>
<td>27</td>
</tr>
<tr>
<td>Baconers</td>
<td>175</td>
<td>28</td>
</tr>
<tr>
<td>Adults</td>
<td>175</td>
<td>49</td>
</tr>
<tr>
<td>Total</td>
<td>830</td>
<td>27.6</td>
</tr>
</tbody>
</table>

**Table 4. Percentage of 830 pigs with eggs per gram in the ranges listed**

<table>
<thead>
<tr>
<th>Species</th>
<th>&lt;99</th>
<th>100-999</th>
<th>1000-1999</th>
<th>2000-2999</th>
<th>3000-3999</th>
<th>4000-4999</th>
<th>&gt;5000</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Oesophagostomum spp</em></td>
<td>72</td>
<td>25</td>
<td>2</td>
<td>0.5</td>
<td>0.7</td>
<td>0.1</td>
<td>0</td>
</tr>
<tr>
<td><em>A. suum</em></td>
<td>92</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>0.3</td>
<td>1</td>
<td>0.3</td>
</tr>
<tr>
<td><em>T. suis</em></td>
<td>93</td>
<td>5</td>
<td>1</td>
<td>0.3</td>
<td>0.1</td>
<td>0</td>
<td>0.4</td>
</tr>
<tr>
<td><em>Strongyloides ransomi</em></td>
<td>98</td>
<td>2</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
few animals.

*Coccidial infections*

The overall prevalence was 20% (Table 5). Prevalence was highest in piglets (32%). The proportion of piglets and weaners infected with coccidia was significantly higher (p<0.05) compared to the proportion of infected adults. At least one animal in each of 32 (91%) herds was excreting coccidial oocysts (Table 5).

**Discussion**

Endoparasites are highly prevalent in pigs raised on commercial pig farms in Thika District. The prevalence was close to that found by Langat. It was comparable to the level of infections reported in USA, Nigeria, Tanzania and Australia. Langat examined the faecal samples of 112 freshly slaughtered pigs in the two main slaughter houses in Kenya, and reported that the prevalence of strongyles (*Oesophagostomum spp.*), *A. suum* and *T. suis* were 50.9%, 10.7% and 4%, respectively. The prevalences in this study for *Oesophagostomum spp.* (27.6%) and *A. suum* (8.3%) were lower than those reported by Langat. The size of the sample, source of pigs as well as the age groups of the animals sampled from the two separate studies could explain the differences observed. The study of Langat did not record any *S. ransomi* because his samples were collected mainly from fatteners (which rarely are infected by this parasite).

That *Oesophagostomum spp.* were the most prevalent parasites is consistent with reports from USA, UK and Ghana. Also consistent with other reports was our findings that the overall prevalence of *Oesophagostomum spp.* infection was higher in adults (sow and gilts) than in other categories of pigs. The least infected group by this parasite were the piglets possibly because the prepatent period of *Oesophagostomum spp.* is 6-7 weeks (a period by which most of the piglets will have been weaned, even if they were infected at birth). The high level of infection in adults is mainly due to the limited immunity which nodular worms (*Oesophagostomum spp.*) stimulate in the host. We recommend that closer attention should be given to worm control in sows, because they are the major source of infection. Even though the eggs

**Table 5. Number of herds and animals infected with coccidia in the area under study**

<table>
<thead>
<tr>
<th>Class</th>
<th>Herds</th>
<th>%</th>
<th>Animals</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piglets</td>
<td>18</td>
<td>69</td>
<td>41</td>
<td>32</td>
</tr>
<tr>
<td>Weaners</td>
<td>21</td>
<td>60</td>
<td>45</td>
<td>28</td>
</tr>
<tr>
<td>Porkers</td>
<td>14</td>
<td>40</td>
<td>27</td>
<td>15</td>
</tr>
<tr>
<td>Baconers</td>
<td>21</td>
<td>60</td>
<td>30</td>
<td>17</td>
</tr>
<tr>
<td>Adults</td>
<td>17</td>
<td>49</td>
<td>22</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>91</td>
<td>165</td>
<td>20</td>
</tr>
</tbody>
</table>

Sampled = Number of herds or animals sampled

Sampled = 26 (Piglets) 130 (piglets)
35 (other groups) 175 (other groups)
of this species are very sensitive to desiccation, the stage 3 larvae (L3) are resistant and may survive for up to one year in the environment\textsuperscript{17}.

The high prevalence of *Oesophagostomum* spp. could have implications to the pig industry since studies have shown that subclinical infections can cause reduction in feed conversion efficiency in growing pigs, weight loss in sows, reduction in litter size and reduced growth in piglets\textsuperscript{1,18}. The overall lower prevalence of this parasite in our study compared to those reported by Gitter et al.\textsuperscript{2} and Esnony et al.\textsuperscript{5} could be because most of the pigs in the present study were reared strictly indoors.

*A. suum* was present in 46% of the pig farms but only in 7% of the animals. This latter prevalence is close to that reported in Kenya\textsuperscript{8} (10.7%), Tanzania\textsuperscript{6} (12%) and Ghana\textsuperscript{7} (12.2%). Higher prevalence of *A. suum* has been recorded in other countries including Nigeria\textsuperscript{5} (96%) and Denmark\textsuperscript{10} (88%). The high prevalence of *A. suum* in Nigerian and Danish studies might reflect different production systems. In both countries pigs were kept under the extensive systems of management where the parasite is known to survive for a prolonged period\textsuperscript{5,16}.

*T. suis* affected mostly the weaners (16%) and porkers (10%), with a very low prevalence among the adults as similarly recorded by Jacob and Dunn\textsuperscript{22}. However other studies found this parasite sporadically and without «preference» to a specific age group\textsuperscript{19}. They attributed the apparent absence of any age dependence to poor acquired resistance in the host population. Beer et al\textsuperscript{23}, showed that this parasite causes profuse bloody diarrhoea, retarded growth and can produce severe anaemia in infected pigs. It should therefore be considered as being important.

*S. ransomi* prevalence (2.3%) was lower than that recorded in some countries such as 35.7% in USA\textsuperscript{21} and 9% in Tanzania\textsuperscript{6}. In other reports, the prevalence of this parasite was either very low or it was absent\textsuperscript{7,24}. The differences could be due to management as well as the variable categories of pigs sampled. In this study, the parasite only affected the piglets and weaners which is consistent with the study by Murrell\textsuperscript{25}. This pattern seems to be closely related to the quick development of acquired resistance\textsuperscript{26}.

The distributions of the four genera of nematode parasites were overdispersed whereby most worms were parasitising only a few hosts. This is a typical of these infections\textsuperscript{27,28,29}.

Mixed infections typically were of *Oesophagostomum* spp. and ascarids (24%) as reported also by Dangolla\textsuperscript{20}. However, the most common farm level monoinfection in the present study was by *Oesophagostomum* spp. but Dangolla\textsuperscript{20} in his study found that most of the farms (41%) carried *A. suum* alone.

The herd prevalence (91%) of coccidia was higher than that reported in Papua New Guinea\textsuperscript{30} (46.6%), Nigeria\textsuperscript{8} (81.1%), and Nordic countries\textsuperscript{31} (17.2%). Crowding of animals due to intensive rearing creates conditions favourable for the buildup of coccidial oocysts and explains those differences. Coccidial oocysts were more prevalent in piglets and weaners than in adults and this agrees with a German report\textsuperscript{32}.

**Acknowledgements**

This study was supported by the University of Nairobi and the authors are most grateful. Thanks are also extended to Ms. Virginia Mumbi and Mr. Richard Otieno for their technical assistance.
References


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PREVALENCE OF SARCOPTIC MANGE IN PIGS IN SMALLHOLDER HERDS IN A PERI-URBAN AREA IN CENTRAL KENYAN HIGHLANDS

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PREVALENCE DE LA GALE SARCOPTIQUE CHEZ LES PORCS DANS DES PETITES EXPLOITATIONS D'UNE ZONE PERIURBAINE DANS LES HAUTS PLATEAUX DU CENTRE DU KENYA

Résumé
Une étude a été entreprise dans 40 troupeaux choisis au hasard dans une zone périurbaine située dans les hauts plateaux du centre du Kenya, afin d'évaluer la prévalence de la gale sarcoptique chez les porcs élevés par des petits exploitants. Au total, 476 porcs de divers groupes d'âge ont fait l'objet d'étude. Le diagnostic était basé sur l'examen physique pour dépister les signes cliniques d'infestation par la gale et sur la détection directe des acaros Sarcoptes scabiei. 90% des troupeaux avaient des signes cliniques de gale sarcoptique et Sarcoptes var suis était positivement identifié chez 70% des troupeaux. Les résultats ont également montré que 273 (57,3%) des 476 porcs avaient des signes cliniques de gale sarcoptique et 90 (18,9%) des 476 porcs étaient positifs à Sarcoptes var suis. La forme hypersensible de la gale était plus fréquente que la forme chronique. La technique d'examen direct pour détecter Sarcoptes var suis était plus efficace chez les porcelets sevrés que chez les autres groupes d'âge de porc. Selon les résultats obtenus, la gale sarcoptique est un problème courant dans les petites exploitations porcines de la région de Kikuyu dans le district de Kiambu au Kenya.

Summary
A study was conducted in forty randomly selected herds in a peri-urban area in the Central Kenyan highlands to obtain prevalence estimates of sarcoptic mange in pigs kept by smallholder farmers. A total of 476 pigs of various age-group categories were enrolled in the study. Diagnosis was based on physical examination for clinical signs indicative of mange infestation and on direct detection of Sarcoptes scabiei mites. Ninety per cent of the herds had clinical signs suggestive of sarcoptic mange and in 70% of the herds Sarcoptes scabiei var suis was positively identified. The results also indicated that 273 (57.3%) of the 476 pigs had clinical signs indicative of sarcoptic mange and 90 (18.9%) of the 476 pigs were positive for Sarcoptes scabiei var suis. The hypersensitive form of mange was more common than the chronic form. The direct examination technique to detect Sarcoptes scabiei var suis was more effective in weaners than in the other age categories of pigs. The results indicate that sarcoptic mange is a common problem in smallholder pig herds in Kikuyu Division of Kiambu District, Kenya.

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Introduction

Sarcoptic mange caused by Sarcoptes scabiei var suis is a highly prevalent and a cosmopolitan disease of pigs. The significant economic losses associated with the disease include reduced growth rate and feed conversion efficiency in growing pigs and reduced sow performance. Prevalence estimates for sarcoptic mange have been recorded in commercial production systems in temperate regions. In contrast, reports from smallholder pig production systems in tropical and sub-tropical countries are few. In Kenya no previous studies have been carried out on the prevalence of sarcoptic mange in smallholder herds. It is possible that poor sanitation may influence the prevalence of sarcoptic mange in these smallholder herds. Therefore, the purpose of this study was to obtain information on the prevalence of sarcoptic mange in smallholder herds at herd- and individual animal-level. Direct identification of Sarcoptes scabiei var suis mites and physical examination to detect signs indicative of sarcoptic mange were used.

Materials and methods

Selection of study farms

The sampling unit was the smallholder pig herd with up to ten breeding sows and/or gilts or up to 100 grower pigs. Five administrative locations in the Division with high numbers of smallholder pig farmers and with easy accessibility were purposively selected. A sampling frame listing all the smallholder pig herds in the five locations who met the above selection criteria was provided by the Government extension officers in charge of each of the locations. A total of 40 herds were randomly selected using a table of random numbers.

Smallholder pig herds

The smallholder pig farmers practised mixed-agriculture and the median farm size was 1 acre. The herds consisted of cross-breeds of Large White, Landrace and Hampshire breeds with a median of 9 pigs per herd. The Pigs were confined in simple houses all the year round. The roofs of the houses were made of iron sheets, the walls were either of wood, iron sheets or stones and the floor typically was concrete in varying degree of disrepair. In the smallholder herds pigs were fed once or twice a day on poor quality commercial feed (69%), swill (26%), self-formulated feed (1.0%) and forage (4.0%).

Finishing pigs were raised up 50-100kg live weight. Majority of the farmers sold the finishing pigs to traders (middle-men) who later sold them at the local slaughter slabs. The hygiene status in most of the herds was poor. The farmers ranked sarcoptic mange as the most common and important disease. However, in all the farms, there was no control programme for the disease in place. Control of the disease was therefore haphazard and the chemicals used by the
farmers were acaricides (50%), engine oil (37%) and combinations of the two (13%).

**Sampling and physical examination procedures**

Sampling was carried out between February and May 2000. Pigs were categorized as piglets (day 1 to 8 weeks), weaners (over 8 weeks to 12 weeks), growers (over 12 weeks to 8 months) and adults (over 8 months).

All pigs in the herds with only a few pigs (<10) were included in the study while pigs in the larger herds (>10) were selected by random sampling. A total of 476 pigs of various age-group categories were selected for the study. From each selected pig, ear wax scraping was taken by scraping the outer ear canal using scraping spoon until traces of blood could be seen. The scraped material was transferred to the sampling containers that were identified by herd and age. In the laboratory, the collected material was digested in 10% potassium hydroxide and examined under the light microscope for the presence of *Sarcoptes scabiei var suis*.

The selected pigs were physically examined for the presence of mange. Those infested with mange were classified as either having the hypersensitive or the chronic form of the disease. The diagnosis of the hypersensitive form was based on presence of localised or generalised erythematous skin papules and/or behaviour indicative of pruritus, such as rubbing against the walls and troughs, and scratching of the flanks or ears with the hind legs (no rubbing index was performed) while that of the chronic form was made on the basis of the presence of asbestos like encrustation in the ears and/or scabs on other parts of the body.

**Data management and analysis**

The data was managed in Access®1997, (Microsoft Corporation, USA). Data analyses were performed using Minitab Statistical Software, release 13 for windows (Minitab Statistical Software, Minitab Inc, USA). Tables of descriptive statistics were generated and the Chi-square test was used to compare the prevalence in the different age-group categories and to compare the prevalence as determined by the two diagnostic methods.

**Results**

Table 1 shows the results of the physical examinations and of mite identifications in the surveyed pigs. Ninety per cent of the herds had signs suggestive of sarcoptic mange and in 70% of the herds *Sarcoptes scabiei var suis* mites were positively identified. Based on both methods, physical examination and mite detection, the herd prevalence was 92.5%.

The results also indicated that 273 (57.3%) of the 476 pigs physically examined had clinical signs indicative of sarcoptic mange. In the pigs with clinical signs indicative of sarcoptic mange, the proportions of the hypersensitive and chronic forms of mange were 85.7% and 14.3%, respectively. The clinical signs suggestive of the hypersensitive form were seen in 49% of the 476 pigs examined. The clinical signs observed in the pigs were erythematous skin patches and papules (80%), rubbing against pen fixtures (80%) and scratching the body with the hind limbs (20%). Clinical signs suggestive of the chronic form were seen in 8% of the 476 pigs examined. The clinical signs observed in these pigs were encrustations and
asbestos-like scabs in the ears and scabs spread all over the body in some pigs, giving them an unpleasant appearance. The hypersensitive form was detected in piglets as early as 3 weeks of age and then in all subsequent age groups, while the chronic form was only seen in the weaners, growers and adult pigs. The hypersensitive form was significantly (p<0.05) more common than the chronic form. The chronic form of the disease was significantly (p<0.05) more frequent in adults as compared to grower pigs.

Sarcoptes scabiei var suis mites were detected in 18.9% (90/476) of the 476 pigs sampled. The prevalence estimate based on physical examination was significantly (p<0.05) higher as compared to mite identification. Mites were significantly (p<0.05) detected at a higher rate in weaners than in the other age groups.

Discussion

The high percentage of herds (70%) where Sarcoptes scabiei-positive pigs were detected and the high prevalence (18.9%) established indicate that sarcoptic mange is a common problem in smallholder herds in Kenya. The prevalence observed was comparable to that recorded (21%) in a similar production system in Tanzania. This high prevalence may be attributed to the poor husbandry and lack of mange control programmes in the study herds.

The clinical signs indicative of sarcoptic mange infestation were similar to those reported by other workers. The clinical signs were observed in 90% of the herds and in 57.3% of the pigs. This was similar to the observations of Kambarang et al. (1990) in Tanzania who recorded the presence of clinical signs in 91% of the herds and 52% of the pigs examined.

<table>
<thead>
<tr>
<th>Age category</th>
<th>Number</th>
<th>Physical signs</th>
<th>Clinical forms</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hypersensitive</td>
<td>Chronic</td>
</tr>
<tr>
<td>detection</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piglet</td>
<td>117</td>
<td>42</td>
<td>42</td>
<td>-</td>
</tr>
<tr>
<td>Weaners</td>
<td>113</td>
<td>64</td>
<td>51</td>
<td>13</td>
</tr>
<tr>
<td>Grower</td>
<td>154</td>
<td>105</td>
<td>95</td>
<td>10</td>
</tr>
<tr>
<td>Adult</td>
<td>92</td>
<td>62</td>
<td>46</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>476</td>
<td>273</td>
<td>234</td>
<td>39</td>
</tr>
</tbody>
</table>
The assessment of the hypersensitive form was done by observing the pigs for signs of pruritus\textsuperscript{3,4,14} as pruritus in infested pigs indicates hypersensitivity to mites\textsuperscript{13}. It has been suggested that within a group of pigs, the maintenance and degree of pruritus is dependent on the presence of infested pigs in the group\textsuperscript{15}. However, the degree of pruritus in pigs is influenced by other factors other than immune mediated hypersensitivity including stocking density and wetting\textsuperscript{4,13} and is therefore non-specific. In addition to an assessment of pruritus, papular dermatitis was used. A significant association between sarcoptic mite infestation and generalised papular dermatitis in a herd has been demonstrated\textsuperscript{7}. Relative to other methods such as skin scrapings or monitoring pigs for pruritus, the use of papular dermatitis for diagnosis of mange is relatively more objective\textsuperscript{15}.

The results from this study indicate that combining a number of clinical signs for diagnosis of sarcoptic mange may be a better method than mite isolation at the herd-level; this was true for all age groups. Mite detection rate in the ear scrapings was highest in weaners and lowest in adults as has been reported in the past\textsuperscript{12}. In contrast, the percentage of pigs with clinical signs suggestive of the hypersensitive form of mange was higher in growers and adults compared to weaners. A decreasing rate of mite detection during the course of an infestation has been reported previo-usuly\textsuperscript{14,16}. This is attributed to the reduced multiplication of mites by a hypersensitivity response that develops in the majority of infected pigs\textsuperscript{1,15}.

The agreement between the direct examination technique and the physical examination for identification of infested herds was good. Therefore, clinical signs can sufficiently be relied upon to identify \textit{Sarcoptes scabiei var suis} infested smallholder herds, where the costs of diagnosis by mite detection are not trivial to the farmers. However, the confirmation of the disease by sampling a few pigs may be necessary due to the none specific nature of the pruritus. The use of a combination of clinical signs to make a diagnosis of sarcoptic mange in smallholder herds is encouraged as the use of papular dermatitis scores at slaughter to assess the hypersensitive form of mange\textsuperscript{7} may not be practical in such herds. This is due to the lack of centralised marketing systems that would allow easy identification of pigs at the slaughterhouse according to herds where they originated from. Therefore, in contrast to commercial systems, the slaughter inspections of pigs to assess the level of hypersensitivity in the herds infested with \textit{Sarcoptes scabiei var suis} may not target the smallholder herds. In addition and in light of the management systems in place the present main aim will have to be to control mange rather than to eradicate the disease. In such circumstances a precise quantification of the prevalence of \textit{Sarcoptes scabiei} mites is of minor importance as such an endeavour is more important when an eradication programme is in progress.

Most of the smallholder farmers did not seem to appreciate the economic loss from mite infestations and majority appeared to regard signs of rubbing in their pigs as a normal phenomenon. The few farmers who treated their pigs for mange did not apply the intervention correctly. Majority of farmers used acaricides that were applied sparingly on the body surface of the animals and were
applied in this manner was unlikely to be effective, as acaricides have no effect against the eggs.

The occurrence of the disease in piglets as early as three weeks indicate that sows may be a potential source of *Sarcoplas scabies var suis*. Chronic lesions that were common in the internal pinna of adult pigs contain large numbers of mites and they may act as a constant reservoir of mites.

Therefore, for the mange intercventions to be effective, the smallholder farmers should use the combination of clinical signs to identify infested pigs. Once the infested pigs have been identified, treatment of pigs with a suitable acaricide at least three times at weekly intervals should be carried out. Particular attention should be placed on the sows that must be treated three times at 7 day intervals, commencing 3 weeks before farrowing and paying special attention to the ears. This intervention will prevent the transmission of mites to the piglets and will ensure improved piglets performance. Although buildings, bedding and other inert materials do not support the mite for more than a few days, it would be a good practice to treat them as the unhygienic and wet conditions that were prevalent in most pig pens are conducive for mite habitation. Proper control of mites would reduce their negative effects on pigs and hence improve their performance.

**Acknowledgements**

We are grateful to the smallholder pig raisers who voluntarily agreed to have this study carried out on their farms. This research was supported by the Agricultural Research Fund (ARF) under contract number ARF/LSKP/RC-IDA/1001004/1 and by the Deutscher Akademischer Austauschdienst (DAAD).

**References**


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NATURAL (CLINICAL) DERMATOPHILOSIS IN THE ONE - HUMPED CAMELS (CAMELUS DROMEDARIUS) SLAUGHTERED IN SOKOTO ABATTOIR, NIGERIA

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LA DERMATOPHILOSE NATURELLE (CLINIQUE) CHEZ LES CHAMEAUX A UNE BOSSE (CAMELUS DROMEDARIUS) ABATTUS DANS L’ABATTOIR DE SOKOTO AU NIGERIA

Résumé

Les escarres au dos, sur les flancs, à la nuque, sur les pattes, sur les lèvres et sur d’autres parties du corps de 528 chameaux (Camelus dromedarius) emmenés pour être abattus à l’abattoir de Sokoto, ont été examinées pour déterminer la présence de Dermatophilus conglobensis à l’aide des méthodes directes de culture et de coloration à gram.

Soixante-deux (11,7%) des chameaux examinés entre mars 2001 et février 2002 étaient affectés par D. conglobensis. L’infection de tous les 62 chameaux a été dépistée avec la méthode de culture, tandis que celle de 60 d’entre eux a pu être détectée grâce à la coloration à gram. Cependant, il n’y avait pas de différence significative (df = 1; x² = 3,2; P > 0,05) entre les deux méthodes pour le dépistage de la dermatophilose chez les chameaux.

Parmi les 365 chameaux examinés pendant la saison sèche, 33 (9,1%) étaient affectés comparé à 29 (17,8%) des 163 examinés durant la saison des pluies. Les taux de prévalence de la dermatophilose étaient beaucoup plus élevés pendant la saison des pluies que durant la saison sèche (df = 1; x² = 8,3; 0,01 > P > 0,001). D’après l’auteur de cet article, il s’agit du premier rapport bien documenté sur la dermatophilose naturelle (clinique) des chameaux au Nigeria.

Summary

Skin scabs from the back, flanks, neck, legs, lips and other parts of the body of five hundred and twenty eight (528) camels (Camelus dromedarius) presented for slaughter at the Sokoto abattoir were examined for Dermatophilus conglobensis by the direct Gram-staining and culture methods.

Sixty two (11.7%) of the camels examined between March 2001 and February 2002 were infected by Dermatophilus conglobensis. All of the 62 infected camels were detected by culture method while 60 of them were detected by Gram-staining. There was however no significant difference (df = 1; x² = 3.2; P > 0.05) between the two methods in detecting dermatophilosis in camels.

Of the 365 camels examined during the dry season, 33(9.1%) were affected while 29(17.8%) of the 163 examined during rainy season were affected. The prevalence rates for dermatophilosis were significantly (df = 1; x² = 8.3; 0.01>P>0.001) higher during rainy season than in the dry season. To the authors’ knowledge this is the first documented report of Natural (Clinical) dermatophilosis in camels in Nigeria.

* Corresponding Author
**Introduction**

Dermatophilosis is a very important skin disease in tropical African and Caribbean countries, having frustrated past efforts to introduce exotic cattle breeds into these countries for the purpose of upgrading the milk-producing ability and body size of local breeds\(^1\). It is a disease of major economic importance in Nigeria\(^2\) and leads to economic loss in dairy, beef, leather and wool industries in the tropics.\(^3\)\(^,\)\(^4\)\(^,\)\(^5\)

The prevalence and chemotherapy of dermatophilosis has been documented with respect to different livestock species including cattle\(^2\)\(^,\)\(^6\) sheep and west African dwarf goats \(^1\)\(^,\)\(^7\). Serological surveys for antibodies against *Dermatophilus congolensis* have been carried out in man, dogs, pigs and camels in Nigeria\(^7\)\(^,\)\(^8\) and Kenya \(^3\) to detect subclinical infections and they indicate reliable methods of field screening of sera for dermatophilosis. The disease is endemic in Nigeria with the average prevalence rates in cattle at 4.1% during dry season and 10.3% during the rainy season\(^9\). Among 5,375 cattle in Ghana it was reported as 4.8% increasing to 12.85% during the dry and the rainy seasons respectively\(^4\). The disease has been

**Table 1: Monthly Prevalence Rate of Dermatophilosis in camels in Sokoto Abattoir**

<table>
<thead>
<tr>
<th>Months / Year</th>
<th>Number of Camels Examinined</th>
<th>Number of Camels Infected</th>
<th>Prevalence Rate %</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>January</td>
<td>43</td>
<td>3</td>
<td>7.0</td>
</tr>
<tr>
<td>February</td>
<td>44</td>
<td>3</td>
<td>6.8</td>
</tr>
<tr>
<td>2001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>March</td>
<td>47</td>
<td>3</td>
<td>6.4</td>
</tr>
<tr>
<td>April</td>
<td>46</td>
<td>4</td>
<td>8.7</td>
</tr>
<tr>
<td>May</td>
<td>48</td>
<td>5</td>
<td>10.4</td>
</tr>
<tr>
<td>June</td>
<td>39</td>
<td>4</td>
<td>12.8</td>
</tr>
<tr>
<td>July</td>
<td>42</td>
<td>7</td>
<td>16.7</td>
</tr>
<tr>
<td>August</td>
<td>41</td>
<td>8</td>
<td>19.5</td>
</tr>
<tr>
<td>September</td>
<td>41</td>
<td>9</td>
<td>22.0</td>
</tr>
<tr>
<td>October</td>
<td>44</td>
<td>6</td>
<td>13.6</td>
</tr>
<tr>
<td>November</td>
<td>44</td>
<td>5</td>
<td>11.4</td>
</tr>
<tr>
<td>December</td>
<td>49</td>
<td>4</td>
<td>8.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>528</strong></td>
<td><strong>62</strong></td>
<td><strong>11.7</strong></td>
</tr>
</tbody>
</table>

Mean number of camels examined = 44±3
reported in nearly all of the African continent and its Islands with the exceptions being Egypt, Lesotho and São Tomé and Principé.

The one-humped camel is usually reared in the Sudan and Sahel savannah (semi-arid) zones of Nigeria. Sokoto state of Nigeria lies within the Sahel zone and is characterized by sparse, thorny, shrub vegetation and very short (3 months) period of rain fall. In addition to its traditional role as the beast of burden and transport, the camel is becoming acceptable as a food animal in those areas of Nigeria where it is reared.

Natural (clinical) dermatophilosis of camels has been reported in Kenya and Sudan where 50 - 75% of adults were affected. No reports of natural (clinical) dermatophilosis have been documented in Nigeria. The purpose of this study was to estimate the prevalence rate of natural (clinical) dermatophilosis of camels presented at slaughter at the Sokoto abattoir, Nigeria.

Materials and Method

Skin scabs of suspected lesions of dermatophilosis in various parts of the body of camels presented for slaughter at Sokoto abattoir between March 2001 and February 2002 were examined by direct microscopy after Gram-staining. Parts of the scabs were thereafter cultured on blood agar. All the skin scabs collected were subjected to both methods of examination. A small quantity of grounded skin scab was placed on a clean glass slide, heat fixed and Gram-stained. The smear was then observed under the microscope's oil immersion for the bacterium. The resulting data were subjected to Chi-square statistical analysis to compare the seasonal prevalence rates.

Results

Microscopic examination of the smears showed typical Gram positive hyphae and cocci. Of the 528 camels examined, 62 (11.7%) were infected with Dermatophilus congolensis. The mean monthly camels examined were 44 ± 3 (Table 1).

Thirty three (9.1%) of the 365 camels examined, comprising 19 males and 14 females were infected during the dry seasons (October to May) while 29 (17.8%) of the 163 examined during the rainy season (June to September) were positive. Of the 29 infected camels 13 and 16 were males and females respectively, (Table 2). The prevalence rates during the rainy season were significantly (df = 1; x² = 8.3; 0.01 > P>0.001) higher than those of the dry season. There was no significant (df = 1 x² = 3.2; P > 0.05) difference in the number of camels infected as detected by both the direct (60 or 13.4%) and culture (62 or 13.9%) methods. All the infected camels detected by Gram-staining were equally detected by culture method.

Discussion

This study presents the first documented reports of natural (clinical) dermatophilosis in the one-humped camels (Camelus dromedarius) in Nigeria. The higher prevalence rates observed during the rainy season were attributable to the wet humid climate known to favour the growth of Dermatophilus congolensis at this period.
Table 2: Seasonal Prevalence Rates of Dermatophilosis in camels slaughtered in Sokoto Abattoir.

<table>
<thead>
<tr>
<th>Season of year</th>
<th>Non-infected camels (sex)</th>
<th>Infected camels (sex)</th>
<th>Prevalence rates (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry season</td>
<td>332 (153M, 179F)</td>
<td>33 (19M, 14F)</td>
<td>9.1</td>
<td>365</td>
</tr>
<tr>
<td>(Oct. to May)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wet season</td>
<td>134 (70M, 64F)</td>
<td>29 (13M, 16F)</td>
<td>17.8</td>
<td>165</td>
</tr>
<tr>
<td>(June to Sept.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>466</td>
<td>62</td>
<td>11.7</td>
<td>528</td>
</tr>
</tbody>
</table>

M = Male
F = Female

of the year. Skin abrasions sustained in the process of browsing, could easily be infected through contact with an infected camel. This explains the higher infection rate observed during the rainy season. Biting flies including Tabanus^3^ and Cephalopina titillator^16^ and ticks which are very active at this period could also contribute to the spread of dermatophilosis among camels. Diseased camels may resist mounting, riding and carrying loads^5^ and may probably have been culled due to dermatophilosis. The disease causes economic loss in hide, skin and leather of affected camels resulting in low market value.

In conclusion, this study shows that dermatophilosis occurs naturally (clinically) in camels in Nigeria. Further research into the pathogenesis and effects of the disease in various age groups of this species in Nigeria is necessary.

Acknowledgment

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References


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A COMPARATIVE EVALUATION OF MILLET, SORGHUM AND OTHER DELIVERY SYSTEMS FOR ORAL NEWCASTLE DISEASE V4 VACCINATION

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UNE EVALUATION COMPARATIVE DU MIL, DU SORGOH ET D'AUTRES MOYENS UTILISES POUR L'ADMINISTRATION ORALE DU VACCIN V₄ CONTRE LA MALADIE DE NEWCASTLE

Résumé
Le mil et le sorgho ont été évalués comme aliments utilisés pour l'administration orale du vaccin V₄ contre la maladie de Newcastle par rapport au manioc et à l'eau potable. Lors d'un test préliminaire de rapidité, une certaine quantité de chacun de ces céréales a été servie à des jours différents à deux poulets ayant un poids et un âge comparables. Le nombre de coups de bec et le poids de l'aliment consommé en un temps donné déterminaient la rapidité. Pour expérimenter le vaccin, 50 jeunes coqs âgés de cinq semaines non-vaccinés ont été répartis en 5 groupes de 10 chacun. À l'exception du groupe-témoin, chaque groupe a été subdivisé en deux : cinq jeunes coqs nourris de céréales contenant le vaccin et les cinq autres comme témoins. La réaction immunitaire a été déterminée par le test IH et l'épreuve au virus vélogène. La rapidité des aliments était classée dans l'ordre suivant : mil > sorgho > manioc. La supplémentation avec 5% de farine d'écrevisse a beaucoup amélioré l'acceptabilité des aliments utilisés, à l'exception du mil, mais elle n'a pas changé l'ordre de rapidité susmentionné. Les poulets vaccinés en utilisant l'eau potable avaient des titres d'anticorps log₂IH plus élevés (6.2±2.40) comparé au manioc (3.75 ± 1.64), au sorgho (4.75 ± 1.08) ou au mil (3.33 ± 0.47). Les différences entre les trois derniers n'étaient pas significatives. Il n'y avait pas non plus de différences notables quant à la réaction immunitaire IH entre les poulets vaccinés directement par le biais des aliments et les sujets-témoins. En général, les poulets vaccinés par le biais du mil et du sorgho étaient aussi bien protégés contre l'épreuve au virus vélogène que ceux vaccinés en utilisant le manioc et l'eau potable respectivement.

Summary
Millet and sorghum were evaluated as carrier-foods for oral Newcastle disease V₄ vaccination in comparison with cassava and drinking water. In a preliminary palatability test a weighed quantity of each carrier-food was given on different days to two chickens of comparable age and weight. The number of pecks and the weight of food consumed in a given time determined palatability. For the vaccination experiment, 50 five-week-old unvaccinated cockerels were divided into 5 groups of 10 each. With the exception of the control group, each group was subdivided into two, 5 chickens to be directly vaccine-fed through carrier-food and 5 contact birds. Immune response was determined by HI test and velogenic virus challenge methods. Carrier-food palatability was in the order, millet>sorghum>cassava. Supplementation with 5% crayfish meal significantly improved acceptability of individual carrier-foods, except millet but did not alter the above order of palatability. Chickens vaccinated through drinking water showed significantly better HI log₂ antibody titres (6.2±2.40) than cassava (3.75±1.64), sorghum (4.75±1.08) or millet (3.33±0.47). The differences between the latter three were not significant. There were also no significant differences in HI antibody response between the directly vaccine-fed chickens and their in-contact counterparts. Overall, chickens vaccinated through millet and sorghum were as protected against velogenic virus challenge as those vaccinated through cassava and drinking water.

Introduction
Food-based vaccination of village chicken flocks with the thermostable V₄ strains has been extensively investigated with varying results. Carrier-foods investigated have been as varied as the stable foods available in the target localities. Commercial pellets and crumbs, wheat, rice, silicon, cassava and maize have been tried with varying degrees of success. A good antibody response (HI log₂ titres of ≥3) had been reported earlier with paddy rice, cooked

*Corresponding author.
rice and maize\textsuperscript{1}, although variations existed even among groups of chickens receiving identical treatments. In other reports, uncooked and unhusked rice, respectively, and indeed uncooked grains generally gave poor results\textsuperscript{2,3,4,5}.

The experiments reported here were aimed at addressing an important requirement for a successful village chicken food-based vaccination programme, namely, identification, in target localities, of carrier-food items that are readily available at little or no expense, that are palatable to chickens and that contain no antiviral factors\textsuperscript{6}. Millet and sorghum are abundantly grown and used as food in the Sahel grassland of Northern Nigeria. Cassava, which had previously been studied\textsuperscript{6}, was included in this study for comparison while drinking water served as a conventional oral vaccination control. Each carrier-food was investigated in the form the natives were likely to apply them without much extra labour input.

Materials and Methods

Experimental Design

This project was carried out in Nsukka, a Local Government Area in Enugu State in the southeastern region of Nigeria. Although millet and sorghum, the grains under evaluation, are not cultivated in this area, they are commonly obtainable from the neighbouring northern states of Benue and Kogi and are readily available in local markets in and around Nsukka town at affordable prices. Hence, they were evaluated as alternative food delivery systems to cassava and drinking water in the project area.

The project set out to investigate, first, the acceptability of millet or sorghum as feed to chickens, with or without protein supplementation and secondly, to evaluate the immune response when the two grains are applied in food-based vaccination. The first objective, which indirectly assessed the feasibility of using the grains in vaccine delivery, was investigated using 2 five-week-old cockerels in a palatability test. The second objective was investigated using 50 unvaccinated cockerels (Arroma Farms, Awka, Nigeria) raised from day-old to 5-weeks in the laboratory and fed on commercial formulation (Guinea Feeds Ltd., Benin City, Nigeria). All birds were screened for NDV-specific HI antibodies before exposure to vaccine and only those showing no detectable antibodies were selected for the experiments.

The 50 chickens were randomly sorted into 5 groups (I, II, III, IV, V), each group consisting of 10 birds. Groups I to IV were exposed to vaccine virus through cassava, millet, sorghum and drinking water, respectively. In each of the first four groups, 5 birds were directly fed with vaccine virus-containing food or water while the remaining 5 were introduced as in-contact birds 2 hr later after thoroughly cleaning out the cubicle. The fifth group (V) consisted of 10 unvaccinated controls. Birds in each group were identified with a wing tag and housed in a separate cubicle.

Feed Preparation and Palatability Testing

Millet and sorghum (white variety) were purchased from the main market in Nsukka town. They were rinsed under running tap water for 2 hrs and subsequently dried in the sun before milling to coarse granules with a mechanical grinder. The cassava, harvested from a farm in Nsukka, was
obtained from G. C. Iroegbu and prepared as previously described\(^6\). Palatability testing of carrier-food with or without crayfish (protein) supplement was also as described earlier\(^8\).

**Evaluation of Vaccine-coated Carrier-food for Capacity to preserve and release Infective Virus**

Purification, reselection for thermostability at 56\(^\circ\) C and production of freeze-dried stock of the V\(_4\)-UPM-NDV supplied by Professor Aini Ideris, Faculty of Medicine and Animal Science, University Partianan, Malaysia, has been described\(^6\). Approximately 10\(^{5.6-6.0}\) EID\(_{50}\) of the vaccine virus was mixed with 1.0 gm of carrier-food (millet, sorghum or cassava) and assayed at 0 hr, 2 hr, 12 hr and 24 hr intervals for virus infectivity by the method of Samuel *et al.*\(^4\). The data obtained were used to calculate the EID\(_{50}\) by the method of Reed and Muench\(^7\).

**Oral Vaccination and Determination of Immunological Response of Vaccinated Chickens**

Vaccine coating of carrier-foods, vaccine feeding and introduction of contact birds were as previously described\(^6\). Following exposure to the vaccine virus, all birds, including the unvaccinated controls were bled by wing vein puncture at weekly intervals for 5 weeks. HI antibody titre of each blood sample was determined by the microtitration method\(^8\). Challenge of vaccinated, in-contact and the unvaccinated (control) chickens was by allowing them to drink water containing 10\(^\text{5} \) EID\(_{50}\)/ml of velogenic NDV. All challenged birds were observed daily for clinical signs and those that died were examined for pathological lesions. Re-isolation of velogenic virus from organs and tissues of deceased birds was attempted.

**Statistical Analysis**

Data obtained from the palatability tests and HI antibody response were statistically compared using the Student t-test and Fisher's least significant difference (LSD)\(^9\).

**Results**

There was positive correlation between number of pecks recorded for a chicken and amount of food (gm) consumed in the process (Table 1). Thus, using pecking as a measure of palatability, cassava supplemented with 5% crayfish was significantly better than the unsupplemented cassava (t\(_\text{cal} = 8.262\); P<0.01) and sorghum supplemented with crayfish better than sorghum without crayfish (t\(_\text{cal} = 2.776\); P<0.05). There was no significant difference between equivalent millet samples (P # 0.05). The chickens pecked sorghum significantly more (LSD = 186.4167; P<0.05) than cassava. Likewise, millet was significantly more acceptable than cassava (LSD = 172.5833; P<0.05). Significantly, crayfish-supplemented sorghum and millet were pecked more frequently than the cassava equivalent (LSD = 1468.5 and 1473.75, respectively; P < 0.01). In all cases, with or without crayfish supplement, the differences between sorghum and millet were not significant (P# 0.05). Using the weight of food consumed as a parameter, supplementation of food with 5% crayfish generally improved palatability by 21-43% (Table 2). The relative persistence of chickens in feeding, which is another indicator of palatability, was assessed from the rate of pecking at given
Table 1: Rate of eating (pecks) and consumption (gm) of millet, sorghum and Cassava by sentinel birds

<table>
<thead>
<tr>
<th>Carrier Food</th>
<th>Mean Number of pecks/hr</th>
<th>Weight of Food consumed (gm)</th>
<th>Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Millet</td>
<td>2587.0</td>
<td>15.4</td>
<td>0.6535</td>
</tr>
<tr>
<td>Sorghum</td>
<td>2253.4</td>
<td>9.9</td>
<td>0.6324</td>
</tr>
<tr>
<td>Cassava</td>
<td>1511.3</td>
<td>6.8</td>
<td>0.9137</td>
</tr>
</tbody>
</table>

Table 2: Effect of Protein-supplementation on Palatability of Millet, Sorghum and Cassava

<table>
<thead>
<tr>
<th>Food</th>
<th>Peck/bird/hr</th>
<th>Percent Improvement</th>
<th>Weight consumed/Bird/hr</th>
<th>Percent improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Millet</td>
<td>3706</td>
<td>NA</td>
<td>15.5</td>
<td>NA</td>
</tr>
<tr>
<td>Millet + 5%</td>
<td>6084</td>
<td>64.2</td>
<td>20.0</td>
<td>29.0</td>
</tr>
<tr>
<td>crayfish</td>
<td>6435</td>
<td>66.9</td>
<td>15.9</td>
<td>20.8</td>
</tr>
<tr>
<td>Sorghum</td>
<td>3855</td>
<td>NA</td>
<td>12.6</td>
<td>NA</td>
</tr>
<tr>
<td>Sorghum + 5%</td>
<td>6435</td>
<td>66.9</td>
<td>15.9</td>
<td>20.8</td>
</tr>
<tr>
<td>Cassava</td>
<td>1745</td>
<td>NA</td>
<td>9.1</td>
<td>NA</td>
</tr>
<tr>
<td>Cassava + 5%</td>
<td>2865</td>
<td>64.2</td>
<td>13.0</td>
<td>42.9</td>
</tr>
</tbody>
</table>

NA = not applicable.
intervals. Figure 1a shows that the frequency of pecking was highest in the first 10 minutes of presentation of millet (170 pecks/min) or sorghum (120 pecks/min) to the chickens. Pecking only reached a low peak of 50/min for cassava at about 40 minutes after what appeared to be an initial reluctance to feed (< 20 pecks/min in the first 10 min). Supplementation with 5% crayfish did not only give an overall higher pecking rate for each carrier-food but resulted in sustained high frequency pecking (60-100 pecks/min) for 30-50 minutes (Figure 1b, c, d).

The results in Table 3 show the recovery of the virus from vaccine-coated feed. Soon after mixing the virus with food and 2 hours later 1 to 2 log_{10} EID_{50} of vaccine virus coated onto food could not be recovered from millet or sorghum. In contrast, an average of 5.5 log_{10} EID_{50} and 4.5 log_{10} EID_{50} of the virus coated onto cassava was recovered after 2hrs and 24hrs, respectively, at room temperature (Table 3).

The HI antibody responses among chickens given a single oral vaccination with the various carriers: - millet, sorghum, cassava or drinking water are represented in Figure 2. The highest mean antibody titres were achieved with drinking water, followed by millet and cassava. These three vaccine carriers stimulated peak antibody responses in about 3-4 weeks. Sorghum-based vaccination stimulated the least antibody response, which did not reach peak even at 5 weeks.

After 3 vaccinations, spaced approximately 3 weeks apart, 60–100% of both vaccine-fed and in-contact birds had detectable antibody levels with mean log_{2} titres of 3.33"0.47 to 6.20"2.40. Antibody response (HI log_{2} titre) was not significantly different between the directly vaccine-fed chickens and the in-contacts in each experimental group (P ≠ 0.05). However, comparing the performance in the four vaccine-carrier systems, water was significantly better than cassava (LSD = 3.4; P<0.05) and sorghum (LSD =4.2; P< 0.05) but not millet (P≠ 0.05). The differences in antibody response between groups I (cassava), II (sorghum) and III (millet) experimental chickens were not statistically significant (P ≠ 0.05).

Challenge with velogenic NDV (VGF-1) produced 20% mortality in group II birds directly fed vaccine in millet and in group III in-contact birds. All other birds exposed to V_{4} in 3 vaccination trials, either directly through feeding in cassava, millet, sorghum or drinking water or indirectly through contact with the latter, survived velogenic virus infection. In contrast, all 10 unvaccinated controls (100%) succumbed to ND (Table 4), often dying suddenly with no discernible central nervous system symptoms. Newcastle disease as cause of death was concluded from the observed clinical signs and/or isolation of velogenic NDV from the deceased birds.

Discussion

The positive correlation between pecking and weight of carrier-food consumed showed the pecking rate to be as good an indicator of palatability as the quantity of food consumed. However, while measurement of the quantity of food consumed showed that supplementation of food with 5% crayfish improved palatability by 21-43%, the pecking rate showed a 60-68% improvement (Table 2). This disparity is
### Table 3: Recovery of Vaccine Virus from Carrier-food.

<table>
<thead>
<tr>
<th>Food</th>
<th>Trials</th>
<th>Vaccine virus titres (log10 EID⁵⁰/gm)</th>
<th>Recovered after time (hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>calculated*</td>
<td>0</td>
</tr>
<tr>
<td>Millet</td>
<td>1</td>
<td>5.6</td>
<td>4.3</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5.6</td>
<td>3.6</td>
</tr>
<tr>
<td>Sorghum</td>
<td>1</td>
<td>5.6</td>
<td>3.6</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5.6</td>
<td>4.5</td>
</tr>
<tr>
<td>Cassava</td>
<td>2</td>
<td>5.6</td>
<td>5.2</td>
</tr>
</tbody>
</table>

*The calculated EID⁵⁰ was determined by estimating the amount of infective virus mixed with 1.0 gm of carrier-food.

### Table 4: HI antibody Report and Resistance to velogenic virus challenge after 3 exposures or contact at 5,8 and 12 weeks of age, respectively.

<table>
<thead>
<tr>
<th>Group of chickens</th>
<th>Vaccination treatment</th>
<th>Number HI positive (%)</th>
<th>Mean HI log₂ titre+ SD</th>
<th>Range HI titre</th>
<th>Percent Mortality on challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Oral-Cassava</td>
<td>4/5 (80)</td>
<td>3.75±1.52</td>
<td>1-5</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>In-contact</td>
<td>5/5 (100)</td>
<td>5.40±1.85</td>
<td>3-8</td>
<td>0</td>
</tr>
<tr>
<td>II</td>
<td>Oral-Millet</td>
<td>3/5 (60)</td>
<td>3.33±0.47</td>
<td>3-4</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>In-contact</td>
<td>5/5 (100)</td>
<td>3.60±1.85</td>
<td>1-6</td>
<td>0</td>
</tr>
<tr>
<td>III</td>
<td>Oral-Millet</td>
<td>4/5 (80)</td>
<td>4.75±1.09</td>
<td>3-6</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>In-contact</td>
<td>4/5 (80)</td>
<td>5.50±2.18</td>
<td>3-9</td>
<td>20</td>
</tr>
<tr>
<td>IV</td>
<td>Oral-Drinking water</td>
<td>5/5 (100)</td>
<td>6.20±2.32</td>
<td>3-9</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>In-contact</td>
<td>4/5 (80)</td>
<td>4.75±1.92</td>
<td>3.8</td>
<td>0</td>
</tr>
<tr>
<td>V</td>
<td>Unvaccinated (control)</td>
<td>0/10 (0)</td>
<td>0.0±0.0</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>
Figure 1: Feeding response (pecks) of chickens to Cassava, Millet or Sorghum with or without crayfish (protein) supplement. (1a reproduced from Iroegbu and Nchinda®)
explained by the selective pecking of the protein supplement, which may contribute very little to the overall weight of the consumed food. Birds are known to exhibit free choice feeding even when all the food constituents are mixed together.\textsuperscript{10,11}

The high acceptability of millet and sorghum met the first condition for using them in vaccine delivery. They had an advantage over cassava that large quantities were consumed within the first 10 minutes of presentation while a small quantity of cassava was consumed in 40 minutes after initial reluctance to feed. Supplementation of millet and sorghum with a protein source (crayfish) further resulted in sustained feeding for 30-50 minutes. All these improved the chances of chickens ingesting immunising dose of vaccine virus before getting distracted. Since unsupplemented millet or sorghum attracted continuous feeding for an average of 10 minutes, it may be necessary to consider providing the immunising dose of vaccine virus in the calculated quantity of food consumed per chicken within this period.

Far less infectious virus particles were released from vaccine-coated millet or sorghum than from cassava. Poor recovery of virus from vaccine-coated food could imply virus inactivation by antiviral factors present in the seed coat. On the other hand, it could mean that the virus is so strongly adsorbed to the seed that it could not easily be dislodged by agitation. While toxic substances on seed surface have been speculated to limit effective use of maize as a vaccine-carrier, lectin on the surface of grains, including millet and sorghum, could bind the vaccine virus such that attempts to recover the virus would fail and be misinterpreted as antiviral activity. In the latter situation, the bound virus could still be available to infect the chicken when ingested. This may explain the relatively good HI antibody response to vaccine-coated millet. It could equally explain the
poor or slow antibody response to the vaccine-coated sorghum in which a peak titre was not achieved even in 5 weeks. In the latter, most of the virus may have been inactivated or there was a slow release of bound virus particles from the grain surface leading to a gradual build up of immunising dose as the virus multiplied in the gut.

The low rate of virus recovery from millet and sorghum notwithstanding, the HI antibody response and protection against velogenic virus challenge after three exposures to these vaccine-coated grains compared favourably with those of cassava and water. The 20% mortality recorded against directly oral-millet-vaccinated group and the in-contact birds of the sorghum-vaccinated group each may be fortuitous. Comparing the latter with the 100% mortality among the unvaccinated control group, millet and sorghum may be seen as performing satisfactorily as delivery systems for V₄ oral vaccination. More studies are still needed to determine the factors affecting optimal performance of these grains as vaccine-carriers including the possible antiviral activities of the grain constituents and chemicals used for preservation of stored commercial grains.

Acknowledgement

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PRODUCTIVITY OF THE GUINEA FOWL (NUMIDA MELEAGRIS) UNDER VILLAGE CONDITIONS IN TANZANIA

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PRODUCTIVITE DE LA PINTADE (NUMIDA MELEAGRIS) DANS DES CONDITIONS VILLAGEOISES EN TANZANIE

Résumé

L'objet de la présente étude était de rassembler des informations sur les méthodes d'élevage et sur certains paramètres physiques et de production des pintades domestiquées en Tanzanie. Des données étaient recueillies grâce à des observations physiques et à des mensurations, et par l'utilisation d'un questionnaire structuré provenant de trois districts (Dodoma, Kongwa et Morogoro). L'élevage en libre parcours est le système d'élevage prédominant et environ 50% des agriculteurs utilisent des cages pour loger les pintades. Le type nacré était le plumage prédominant dans tous les districts (87,5%). Les pintades des deux sexes dans tous les districts avaient une couronne. Les poids vifs moyens des adultes étaient de 1,65 kg pour les mâles et 1,85 kg pour les femelles. L'âge moyen à la première ponte et la durée de la saison de ponte étaient de 9,14 ± 1,50 et 6 mois respectivement, la saison allant de septembre à mai. Dans des conditions villageoises, le nombre moyen d'œufs pondus/pintade/an et le poids de l'œuf était de 125, 9 g et 43,03 g respectivement. La taille de la couvée par pintade était en moyenne de 12,2 ± 5,09 avec une éclivité moyenne de 82,6%. Le taux de mortalité global à 8 semaines était de 55,5%, une mortalité due surtout aux prédateurs. Certains obstacles ainsi que les potentialités susceptibles d'améliorer l'exploitation des pintades ont été identifiés. Il a été conclu qu'il est fort possible d'accroître la production de pintade grâce à une gestion appropriée et la pintade peut être un complément aux poulets locaux à cause de leur plus forte et inhérente résistance aux maladies, en particulier la maladie de Newcastle.

Summary

This study was conducted with the objective of documenting husbandry practices and some physical and production parameters of domesticated guinea fowls in Tanzania. Data were collected through physical observations and measurements and by use of structured questionnaire from three districts (Dodoma Rural, Kongwa and Morogoro Urban). Free range is the predominant system of rearing and about 50% of the farmers provide some housing to the birds. Pearl type was the predominant p-lumage pattern in all districts (87.5%). Birds of both sexes in all districts were helmeted. The average live weights of adults were 1.65 kg for males and 1.85 kg for females. The average age at first egg and length of laying season were 9.14±1.50 and 6 months respectively; the season falling between September and May. Under village conditions, the mean number of eggs laid per bird per year and egg weight was 125.9 and 43.03 respectively. The average clutch size of eggs set per bird was 12.2±5.09 with a mean hatchability of 82.6%. Overall keet mortality to 8 weeks was 55.5%, most of the death being due to predations. A number of constraints and potentials to improving guinea fowl farming were identified. It was concluded that there is great scope for improving guinea fowl production through management interventions and guinea fowl complement local chickens owing to their inherent higher resistance to diseases, especially New Castle disease.

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Introduction

Guinea fowls are widely acknowledged as an attractive option for expanding rural poultry production. In West and Central Africa, for example, guinea fowls are commercially managed, usually intergrated with other domestic birds such as chicken ducks and goose\textsuperscript{1,2}. In Tanzania, guinea fowls are more commonly found in the southern part of the country such as Mtwaru, Lindi and Ruvuma, accounting for approximately 70.4\% of the total guinea fowl population in Tanzania\textsuperscript{3}. However, little is known of their husbandry in Tanzania. Indeed guinea fowls are assumed to have the same husbandry requirements as the scavenging rural chicken.

In Tanzania, despite the common occurrence of guinea fowls in many households and their merits, no systematic studies have been made to evaluate their potential as domesticated birds. In Nigeria, India and South Africa where guinea fowls are considered to be potential base for the diversification of poultry production, some extensive studies have been done on their productivity. The present study was, conducted in order to characterise and document on the production potential of guinea fowl under village conditions in Tanzania with the view to identifying their productivity, economic and social-cultural aspects, the current rearing practices and constraints impending guinea fowl production.

Materials and Methods

Study areas and sampling

Surveys were conducted in two regions namely, Dodoma and Morogoro. Dodoma lies within the arid central plateau, while Morogoro has diverse ecosystem ranging from semi-arid to sub-humid ecozones. Altogether 6 villages were purposefully visited in two districts of Dodoma viz. Dodoma rural (Mvumi, Makuru and Mvumi Mission), Kongwa (Kongwa Urban, Mbande and Sejeli) while in Morogoro the survey was conducted within the peri-urban areas. The survey was done between February and April (during rainy season) and only those farmers keeping guinea fowls were interviewed.

Physical measurements:

Body weight and egg measurements

A total of 194 mature guinea fowl and 175 eggs were sampled and weighed during the field visit. Seventy-five fresh eggs were randomly sampled, broken and following egg components weighed: yolk (YW), albumen (AW), and shell together with its membranes (SW). Egg shape index - was obtained from the ratio of egg length (mm) to breath (mm).

On-station determination of fertility and hatchability.

279 guinea fowls eggs were purchased from local keepers in two batches and were incubated artificially in an electrical incubator. Candling was done between the 24 and 26th days after incubation to check for fertility or embryo mortality. Percent egg fertility was determined as ratio of number of fertile eggs to the total number of eggs incubated. Hatchability was expressed as the ratio of keets hatched to the number of fertile eggs set. On the 30th day, eggs that failed to hatch were cracked open and the number of dead-in-shell embryos counted. Percent dead-in-shell embryos were expressed as a proportion of the number.
Table 1: Percentages of respondents on management variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Location</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dodoma</td>
<td>Kongwa</td>
<td>Morogoro</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(n=55)</td>
<td>(n=19)</td>
<td>(n=17)</td>
<td></td>
</tr>
<tr>
<td>Rearing system</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free range</td>
<td>90.9</td>
<td>78.9</td>
<td>85.7</td>
<td></td>
</tr>
<tr>
<td>Semi-intensive</td>
<td>7.3</td>
<td>5.3</td>
<td>14.3</td>
<td></td>
</tr>
<tr>
<td>Intensive</td>
<td>1.8</td>
<td>15.8</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Supplementation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free range</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Yes</td>
<td>87.3</td>
<td>68.4</td>
<td>85.7</td>
<td></td>
</tr>
<tr>
<td>- No</td>
<td>9.1</td>
<td>15.8</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Intensive</td>
<td>3.6</td>
<td>15.8</td>
<td>14.3</td>
<td></td>
</tr>
<tr>
<td>Feed problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Yes</td>
<td>40.0</td>
<td>21.1</td>
<td>28.6</td>
<td></td>
</tr>
<tr>
<td>- No</td>
<td>60.0</td>
<td>78.9</td>
<td>71.4</td>
<td></td>
</tr>
<tr>
<td>Housing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special house</td>
<td>36.4</td>
<td>42.1</td>
<td>71.4</td>
<td></td>
</tr>
<tr>
<td>No special house</td>
<td>63.6</td>
<td>57.9</td>
<td>28.6</td>
<td></td>
</tr>
<tr>
<td>Diseases</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Yes</td>
<td>9.1</td>
<td>0.0</td>
<td>14.3</td>
<td></td>
</tr>
<tr>
<td>- No</td>
<td>90.9</td>
<td>100.0</td>
<td>85.7</td>
<td></td>
</tr>
<tr>
<td>Vet. Services</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Yes</td>
<td>0.0</td>
<td>5.3</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>- No</td>
<td>100.0</td>
<td>94.7</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

n = Number of respondents
of fertile eggs set.

Management and performance characteristics

Selected farmers were interviewed using structured questionnaires that were formulated to obtain basic information of interest on the management systems and on reproductive and production performances of guinea fowls in their local environment. The information included, flock number, acquisition of initial stock, mating ratio, age at first laying, number of eggs per clutch and per year, number of eggs set for incubation, hatchability, keet mortality, weaning time, rearing system, seasonality in egg production (if any) supplementary feeding (if any) and type of feed, diseases and their control measures, marketing, major problems and benefits of guinea fowl over local chicken.

Data analyses

Body weight and egg measurements

Statistical analyses for various body measurements, egg measurements and coded data from the questionnaire were performed according to the General Linear Models (GLM) procedure (SAS, 1990d).

Results

Physical characteristics

All birds were helmeted and the predominant plumage characteristics were Pearl, followed by Grey or White breasted and White. Dodoma and Kongwa guinea fowls were all Pearl type, while Morogoro had all the three types. The predominant head colours were white and shades of bluish and yellowish white. There was little difference in physical appearance between males and females under the age of eight months. However, farmers could distinguish sexes shortly after eight months, when males become distinguishable by their comparatively larger helmet and wattles.

Management

Most of the interviewed farmers kept about five to ten birds. Of the birds kept the keets constituted between 50% and 70% of the flock in the three locations. Adult males made up between 13% and 23% of the flock, giving a male:female ration of 1:5.

Free range was the most predominant management system in the areas studied. More than 80% of the respondents practised this system (Table 1).

This system of management in over 70% of the respondents did not single out feeding to be a major problem. Unlike domestic chickens, disease incidences were low, whereby over 90% of respondents observed that guinea fowls did not succumb to disease easily. Likewise, about 50% of the farmers provided a special house for the guineas and the remaining 50% did not.

Performance characteristics

The least square means and their standard errors for the body measurement, egg production, egg set per hen, hatchability, keet mortality, male:female ratio and age at first lay under village conditions are presented in Table 2. Weight of mature birds ranged from one to three kilograms, females being significantly (P<0.05) heavier than males in all locations.

The number of eggs set per hen, eggs
Table 2: Productivity of guinea fowls (LS means± se) by locality

<table>
<thead>
<tr>
<th>Variable</th>
<th>Dodoma</th>
<th>Kongwa</th>
<th>Morogoro</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male wt (kg)</td>
<td>1.59±0.03a</td>
<td>1.63±0.07a</td>
<td>1.75±0.07b</td>
<td>1.6±0.18</td>
</tr>
<tr>
<td>Female wt (kg)</td>
<td>1.79±0.04a</td>
<td>1.72±0.08a</td>
<td>1.75±0.07b</td>
<td>1.60±0.18</td>
</tr>
<tr>
<td>(n)</td>
<td>(37)</td>
<td>(38)</td>
<td>(41)</td>
<td></td>
</tr>
<tr>
<td>No. Eggs/bird/year</td>
<td>131.6±5.4a</td>
<td>113.7±10.2a</td>
<td>110±14.9</td>
<td>125.9±39</td>
</tr>
<tr>
<td>No. Egg set/hen</td>
<td>12.6±0.7a</td>
<td>11.3±1.2a</td>
<td>11.1±1.9a</td>
<td>12.2±5.1</td>
</tr>
<tr>
<td>Hatchability (%)</td>
<td>78.2±2.3a</td>
<td>91.8±3.9b</td>
<td>92.4±6.2b</td>
<td>82.6±17.4</td>
</tr>
<tr>
<td>Keet mortality (%)</td>
<td>54.7±3.9a</td>
<td>59.6±6.6a</td>
<td>51.0±10.6a</td>
<td>55.5±27.7</td>
</tr>
<tr>
<td>Male:Female ratio</td>
<td>1:1.4a</td>
<td>1:2.1b</td>
<td>1:1.2a</td>
<td>1:1.5</td>
</tr>
<tr>
<td>Age at first lay (Months)</td>
<td>8.9±0.2a</td>
<td>10.4±0.3b</td>
<td>8.2±0.6a</td>
<td>9.14±1.5</td>
</tr>
</tbody>
</table>

Means with superscript letters not in common within a row are significant different (P<0.05)

Laid per bird per year and keet mortality did not differ significantly (P<0.05) between locations. Significant differences (P<0.05) were observed in hatchability, male:female ratio and age at first lay. The overall mean for age at first lay was 9.1 months, ranging between 8.2 - 10.3 months and weaning of keets took place at the age of 1 to 6 months, with the majority of farmers reporting a period of 2 - 3 months.

Egg production and components

The average number of eggs laid per bird per year was 125, with a mean hatchability of 82.6% (Table 2). However, results of on-station egg setting showed a relatively low fertility (29.7%) and hatchability (6%), with a high percentage dead in shell (93.9%) (Table 3).

Means and standard deviations for egg parameters are presented in Table 4.

Mean egg weight, egg length, egg width and egg index were 43.0±3.5, 50.9±1.7, 39.8±1.0 and 78.2±2.9 respectively. Yolk weight, albumen weight and egg shell weight expressed as percentage of the egg weight were 33.9±1.0, 49.6±2.9 and 16.0±0.9 respectively.

Merits and demerits of guinea fowl production

The relative merits of guinea fowl production in comparison with domestic chickens are shown in Table 5. High price and the ability of guinea fowl to tolerate diseases were the most motivating factors in keeping the guineas in Dodoma. Moreover, over 40% of the respondents included in addition, the ability of the guineas to lay many eggs as an added advantage. Problems encountered in
keeping guinea fowls in order of importance included high keet mortality, noise from the birds, theft and destruction of crops during planting season.

Discussion

The study showed that Morogoro district differed in plumage characteristics from the districts of Dodoma and Kongwa. The plumage colour diversity noted in Morogoro could be due to the proximity of Morogoro to the game reserves of Mikumi, Selous and Ruaha. The Ruaha game reserve is home to the Pearl type, while in Mikumi reserve there is a mixture of the Pearl and Grey-breasted guinea fowls. Since all types are inter-fertile one may expect hybrids of wide variations in the plumage characteristics.

With regard to management, it was observed also that guinea fowl are kept either alone or in a mixed flock with local chicken and/or ducks. Birds are usually left to scavenge during daytime and the commonest source of feed is the range with minor supplementation of grains and kitchen leftovers. Full-confinement was practised by only a few farmers, and such farmers reported availability of feeds to be a serious problem during some parts of the year, especially during planting period, as birds have to be confined. Similar observations were reported by Ayanda\(^3\). Although no serious disease outbreaks were reported on guinea fowls, mortalities were notably high for keets under the age of 8 months. This observation agrees with past findings in Nigeria\(^5,6\). The major disease affecting guinea fowls under the age of 8 weeks were however, not clearly identified by farmers due to lack of knowledge on types of diseases and the absence of veterinary services. Moreover, it was evident that while local chicken were invariably decimated by New Castle disease, guinea fowl were relatively immune.

The observed male:female ratio of 1:5 is similar to observation by Gonzalez and Klein\(^7\) who observed high fertility (92%) in flocks where the male:female ratio was 1:5 compared to those in which the ratio was 1:3 or 1:7. Unlike in domestic chicken, it appears that the territorial and monogamous nature of guinea fowl dictate for higher male:female ratio to achieve higher fertility. In Dodoma and Kongwa farmers do not keep adult guinea fowls for longer than two years, an observation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Settings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st setting (n=147)</td>
</tr>
<tr>
<td>% Fertility</td>
<td>20.4</td>
</tr>
<tr>
<td>% Hatchability</td>
<td>16.7</td>
</tr>
<tr>
<td>% Dead in shell</td>
<td>83.3</td>
</tr>
</tbody>
</table>

n = Number of eggs
Table 4: Egg parameters: Means and standard deviation (n = 75)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std dev.</th>
<th>Percentage(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg weight (g)</td>
<td>43.03</td>
<td>3.56</td>
<td></td>
</tr>
<tr>
<td>Egg length (mm)</td>
<td>50.98</td>
<td>1.72</td>
<td></td>
</tr>
<tr>
<td>Egg width (mm)</td>
<td>39.83</td>
<td>1.05</td>
<td></td>
</tr>
<tr>
<td>Egg index</td>
<td>78.20</td>
<td>2.97</td>
<td></td>
</tr>
<tr>
<td>Yolk weight (g)</td>
<td>14.62</td>
<td>1.00</td>
<td>33.9</td>
</tr>
<tr>
<td>Albumen weight (g)</td>
<td>21.36</td>
<td>2.89</td>
<td>49.6</td>
</tr>
<tr>
<td>Eggshell weight (g)</td>
<td>7.06</td>
<td>0.90</td>
<td>16.0</td>
</tr>
</tbody>
</table>

\(^1\)Percent of egg weight

Table 5: Relative merits of guinea fowls against local domestic chickens as perceived by respondents

<table>
<thead>
<tr>
<th>Variable</th>
<th>Dodoma n=55</th>
<th>Location</th>
<th>Morogoro n=17</th>
</tr>
</thead>
<tbody>
<tr>
<td>High price</td>
<td>3.6</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>High price and disease resistant</td>
<td>60.0</td>
<td>26.3</td>
<td>28.6</td>
</tr>
<tr>
<td>Many eggs</td>
<td>0.0</td>
<td>10.5</td>
<td>0.0</td>
</tr>
<tr>
<td>No. 2 &amp; 3 above</td>
<td>32.7</td>
<td>52.6</td>
<td>42.9</td>
</tr>
<tr>
<td>No. 1 &amp; 3 above</td>
<td>1.8</td>
<td>5.3</td>
<td>28.6</td>
</tr>
<tr>
<td>None</td>
<td>1.8</td>
<td>5.3</td>
<td>0.0</td>
</tr>
</tbody>
</table>

n = Number of respondents
similar to that reported in Nigeria and India\textsuperscript{6,9}. The reasons advanced were that too many guineas contributed to crop damage and that during planting season there is scarcity of feeds for confined birds. Likewise, mature guinea fowls fetch a better price than chicken and this encourages farmers to sell off their adults and retain just a few for breeding.

In this study the weight of guinea fowls ranged from one to three kilograms, females being significantly (\textit{P}<0.05) heavier than males. Similar findings were reported in West Africa guinea fowl population\textsuperscript{10}. This phenomenon is unique in guinea fowls because in most other domestic birds, males are heavier than females. However, for pre-pubertal females there were no significant differences in weight between the sexes. Since the survey study was done during the rainy season (February - April), it is likely that the adult females were in season for egg laying, a period when females are known to have higher synthetic and storage activities for egg-yolk components in the liver\textsuperscript{10}.

Most respondents (about 93\%) in the study area indicated that the guinea fowls are seasonal breeders and they attain sexual maturity at about 9 months. This result is in close agreement with past observations\textsuperscript{11,12,13}. Moreover, improved guinea fowls the age at sexual maturity could be reduced by 2-3 months\textsuperscript{14}. Moreover, under unimproved village conditions farmers reported that egg production tend to be the rainy season (September to May). The most attributing factor being the improved food supply (e.g. insects, green matter, etc).

The average number of eggs laid per bird per year (i.e. 125 eggs) suggests that guinea fowls have a more intensive laying rate than local chickens under village management. This rate of laying is higher than that reported literature for local chicken\textsuperscript{11,12}, but within the estimates reported in South Africa and Nigeria\textsuperscript{13,16}. Keets hatched by domestic chicken are normally reared by the hen as foster mother, a sight commonly observed in the villages. This practice apparently allows the guinea fowl to continue with laying more eggs over an extended period of time making it possible for the guinea fowl to attain their maximum reproduction capacity under natural conditions. Moreover, guinea fowls are known for their habit of laying in the bush, where at times it may not be possible to find the eggs. Again the constant danger of vermin scavenging for guinea fowl’s egg compound the problem of getting reliable estimates of egg yield under village conditions.

Contrary to the belief that guinea fowl eggs have poor hatchability, guinea fowls in Morogoro and Kongwa were reported to have hatchability as high as 90\%, an observation similar to that reported by Ayorinde\textsuperscript{15}. However, eggs collected from the field and artificially incubated showed poor fertility and with high percentage dead in shell. Ayorinde and Okaeme\textsuperscript{17} reported similar low values. By contrast, fertility rate of 78\% and hatchability of 71\% from improved stock kept in a temperate area of South Africa have been documented\textsuperscript{18}. The low hatchability observed by some farmers and researchers could be attributed to the fact that often eggs are stored for long duration before they are incubated, a factor that contribute to low hatchability. It has been noted that that for every day of storage, hatchability deteriorate by nearly 4\%\textsuperscript{6}. This is especially so for farmers with small flocks as they attempt to raise the
number of eggs before selling them. The high hatchability observed in this study following interview with the farmers and in many other studies implies that under natural conditions the fertility and hatchability rates are higher than what is generally believed.

Means of egg parameters compare well with those reported by other researchers. The proportion of yolk and albumen were higher than those of domestic chicken eggs. Measurements on egg shape index, yolk, albumen and eggshell weights were not compared with other finings, but indicated as benchmark for future research.

It appeared from this study that the most passing problems which farmers encounter in guinea fowl production include keet mortality, and feeding during the planting season. Others which farmers also listed as problems are guineas laying in the bushes, hence loss of eggs, and damage of crops during planting periods. Keet mortality was more than fifty percent and most of deaths were reported to occur before 8 weeks. A number of factors including poor management, diseases and predation by dogs and cats were cited to attribute to the low survival rates of keets. Other studies have attributed these high losses to helminthiasis, vitamin deficiency, cold stress and suffocation.

Despite these problems a number of farmers (about 97.6%) listed the merits of guinea fowls to be high selling price of both live birds and eggs, disease resistance and many eggs as compared to local chickens raised under similar conditions. As such, we can speculate that high prices offered (about 4.2 US Dollars for an adult guinea fowl and 0.24 US Dollars for an egg compared to 1.7 and 0.05 US Dollars for a

local chicken and an egg respectively) and disease resistance, particularly Newcastle disease, were the motivating factors for keeping guinea fowl.

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References


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STUDIES ON POULTRY COCCIDIOSIS IN DIFFERENT PRODUCTION SYSTEMS IN DEBRE ZEIT AND SURROUNDING AREAS, ETHIOPIA

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ETUDE SUR LA COCCIDIOSE DES VOLAILLES DANS DIFFERENTS SYSTEMES DE PRODUCTION A DEBRE ZEIT ET DANS LES REGIONS ENVIRONNANTES EN ETHIOPIE

Résumé
L'objet de la présente étude était de déterminer la prévalence de la coccidiose des volailles et d'identifier les espèces de coccidies incriminées. La bande de volailles faisant l'objet d'étude étaient composées de poulets de gril et de pondeuses dans 26 fermes avicoles où 1028 échantillons fécaux ont été recueillis au hasard. Les examens fécaux qualitatifs et quantitatifs ainsi que les examens antemortem et postmortem ont été effectués. Une enquête à l'aide d'un questionnaire a été réalisée pour évaluer la performance de la ferme, l'histoire de la maladie dans la ferme, les méthodes d'exploitation et les facteurs de risque potentiel pour la coccidiose. Des ovocytes de coccidies étaient détectés dans 81,1%, 80,3%, 72,9%, 6,8% et 4,8% des échantillons fécaux issus des petites fermes d'élevage de poules, des grandes fermes d'élevage de poulets de gril, des petites fermes de poulets de gril, des grandes fermes de pondeuses avec un système d'élevage utilisant une litière permanente et des grandes fermes de pondeuses avec un système d'élevage utilisant des cages respectivement. Le nombre d'ovocytes par gramme de fèces était beaucoup plus élevé (P = value = 0,024) dans les fermes de poulets de gril et de poulettes que dans les fermes de pondeuses. Les lésions dues à la coccidiose dans les appareils gastro-intestinaux étaient dépistées chez 92 (48,2%) , 94 (47,2%) et 12 (40%) pintades examinées dans les grandes fermes de poulets de gril, les petites fermes de poulet de gril et les petites fermes de poulettes respectivement. Les proportions de coccidiose infraclinique étaient plus élevées que celles de coccidiose clinique. Eimeria acervulina (34,4%), Eimeria tenella (32,8%), Eimeria maxima (8,6%) et Eimeria necatrix (4%) étaient identifiées et il y avait 20,2% de cas d'infections mixtes.

Summary
This study was designed to determine the prevalence of poultry coccidiosis and identify species of coccidia involved. The study population consisted of broiler and layer chickens in 26 poultry farms where 1028 faecal samples were randomly collected. Qualitative and quantitative faecal examinations as well as antemortem and postmortem examinations were carried out. A questionnaire survey was conducted to assess farm performance, farm disease history, management practices and potential risk factors for coccidiosis. Coccidia oocysts were detected in 81,1%, 80,3%, 72,9%, 6,8% and 4,8% faecal samples from small scale pullet rearing farms, large scale broiler farms, small scale broiler farms, large scale layer farms with deep litter rearing system and large scale layer farms with cage rearing system respectively. The means of oocysts per gram (OPG) counts were significantly higher (P-value = 0,024) in broiler and pullet rearing farms than those of layer farms. Lesions due to coccidiosis in the gastrointestinal tracts were detected in 92 (48,2%), 94 (47,2%) and 12 (40%) birds which were examined in large scale broiler, small scale broiler and small scale pullet rearing farms, respectively. Proportions of subclinical coccidiosis were higher than those of clinical coccidiosis. Eimeria acervulina (34,4%), Eimeria tenella (32,8%), Eimeria maxima (8,6%) and Eimeria necatrix (4%) were identified and 20,2% were mixed infections.

* Corresponding Author.
Introduction

Poultry is among the important group of livestock kept in Ethiopia. Alemu and Tadelle\textsuperscript{1} identified three poultry production systems. They include backyard poultry production system, small scale and large scale intensive poultry production systems. The total poultry population in the country is estimated to be 56.5 million. The subsector is concerned with egg and meat production for income generation and home consumption\textsuperscript{2}.

Poultry production has the potential to create both rural and urban employment, improve the nutritional status of the people and can be easily sold in time of economic difficulty to generate income. However, poultry production in Ethiopia has been hindered by diseases among other factors. Mortalities due to diseases are estimated to be between 20\% and 50\% but can be as high as 80\% during times of epidemics\textsuperscript{3}.

Coccidiosis has been referred to as a disease due to intensification of livestock keeping. This makes coccidiosis an important disease deserving attention especially with regard to its prevention and control\textsuperscript{4}.

In Ethiopia, coccidiosis is endemic, causing great economic losses particularly in young growing birds in all production systems\textsuperscript{5,6}. In the past years coccidiosis used to be the most important cause of mortalities in all farms. The disease continued to be a problem as reported by Fessesse-work\textsuperscript{8} who recorded prevalence rates of 50.8\% and 11\% in deep litter intensive systems and backyard poultry production systems, respectively. Other reports are by Kalifa\textsuperscript{7}, who recorded prevalences of coccidia lesions in dead birds of 44.8\% in Lemlem and 21.5\% in Tsedey farms both of which are large scale commercial poultry farms in Debre Zeit. Hagos\textsuperscript{8} reported a prevalence of 20\% clinical and subclinical coccidiosis in local chickens in Central Ethiopia.

Despite the economic significance of the disease to the commercial poultry producer and the country in general, no substantial research work has been done to determine the prevalence of the disease and particularly to assess its economic losses. The primary objective of this study was due to it therefore to establish baseline data on poultry coccidiosis and identify the prevalent species of coccidia in different production systems in the study area.

Materials and Methods

The study area

The study was conducted between February and August, 2001. Study areas included urban and peri-urban areas of Debre Zeit in Ethiopia. Debre Zeit, with a human population of about 95,000 is located 45 kilometers south-east of Addis-Ababa at an altitude of 1,800 meters above sea level. The average annual temperature, rainfall and humidity are 18.7°C, 866 mm and 50.9\%, respectively\textsuperscript{9}.

The study population

The study population consisted of broiler and layer chickens in 26 small scale and large scale poultry farms. These included 5 large scale broiler farms, 6 large scale layer farms, 12 small scale broiler farms and 3 small scale pullet rearing farms. Large scale poultry farms had flock sizes that ranged from
4,000 to over 80,000 per farm.

Study design

The study comprised a cross sectional study to determine the prevalence of coccidiosis in poultry and the prevalent species of coccidia in the study areas.

Cross sectional study

This study was conducted through parasitological examination of faecal samples collected from selected poultry houses. This was followed by antemortem and postmortem examination of representative birds selected from the same poultry houses.

Parasitological examination of faecal samples

To demonstrate the presence and level of coccidia infection in the study poultry farms, qualitative and quantitative faecal examinations were carried out using the techniques described by Hansen and Perry\textsuperscript{10}. In the case of very high counts, dilution of the faecal suspension to 10 times its original volume was done to simplify counting.

Sporulation of coccidia oocysts

To assist in species identification, sporulation of coccidia oocysts was carried out. Sporulation time was recorded when at least 90% of oocysts had sporulated\textsuperscript{11}. Themorphology and sizes of sporulated oocysts were microscopically determined using a calibrated ocular micrometer at 40X magnification. The sizes for a given specie (length and width) were determined by measuring at least 50 oocysts and calculating the average according to Long and Reid\textsuperscript{12}.

Antemortem and postmortem Examination of birds

Birds for antemortem and postmortem examination were randomly selected from poultry houses in all the study farms in which coccidiosis was found to be a problem. The procedure was performed according to Conway McKenzie\textsuperscript{11} and Long and Reid\textsuperscript{12}.

Gross examination

After antemortem examination, the birds were sacrificed by cervical dislocation and opened to expose the abdominal cavity and viscera. The intestinal walls and the mucosa were examined for gross lesions related to coccidiosis. Lesions were scored on a scale ranging from 1-4; whereby 1 = mild lesion, 2 = moderate lesion, 3 = severe lesion and 4 = very severe lesion. A score of 0 meant no lesion\textsuperscript{11}.

Identification of species of coccidia

This was based on sporulation time, shape and size of sporulated oocysts, and on the nature/type and location of the observed gross lesion. The information from all these findings were combined and compared with the identification key of Long and Reid\textsuperscript{12} for confirmation of the species identified.

Questionnaire survey and assessment for potential risk factors for coccidiosis

At least one set of questionnaires was administered to every farm which was included in the study. Targeted respondents were farm managers or farm veterinarians for large scale poultry farms. For small scale poultry farms respondents were farm owners.
Sample size determination for cross sectional study

Faecal samples: The sample size was estimated depending on the expected prevalence of coccidiosis in the study area and the desired absolute precision according to Thrusfield\textsuperscript{13}.

Number of live birds: A modification of minimum sample size suggested by Razmi and Kalideri\textsuperscript{14} of 10 birds/10,000 birds was taken. A total of 420 birds were selected of which 191 were from large scale poultry farms and 229 from small scale poultry farms.

Sampling procedures

The production systems in which the study was conducted were purposively selected. For each production system, all poultry farms which could be identified were included in the study. Except in large farms with more than four poultry houses, faecal and necropsy samples were randomly selected from all poultry houses. Where the farm had more than four poultry houses, a two stage simple random sampling procedure was adopted by selecting the poultry houses first and then the faecal or necropsy samples in the selected poultry houses\textsuperscript{13,15}. Feecal samples were picked by moving in a zigzag way around the entire poultry house. In farms where birds were kept in cages, faecal sampling was done in such a way that all places were represented. Birds for necropsy were picked in a similar manner.

Data management and analysis

Means of OPG counts and their respective standard deviations were recorded using their original scale. The mean OPG counts among different production systems were compared using Kruskal Wallis Test\textsuperscript{16}. Testing for significant difference in frequency of detection of coccidia oocysts in faecal samples and prevalence of coccidiosis among different poultry production systems and age groups of chickens was performed using the Chi-Square Test\textsuperscript{16} Assessment for economic impact of coccidiosis was performed using gross margin analysis\textsuperscript{17}.

Results

Cross sectional study

Parasitological examination of faecal samples:

The means of OPG counts were significantly higher (p-value = 0.024) in broiler and pullet rearing farms than those from layer farms. There was no significant difference (P-value = 0.296) in means of OPG counts between large scale broiler and small scale broiler/pullet farms. Similarly there was no significant differences (P-value = 0.563) of means of OPG counts between small scale broiler farms and small scale pullet farms, and between large scale layer farms with different rearing systems (P-value = 0.064). There was a significant difference in frequency of detection of coccidia oocysts in faecal samples among the different poultry production systems. The frequency was highest in small scale pullet farms (81.1%) followed by large scale broiler farms (80.3%) and small scale broiler farms (72.9%). It was followed by large scale layer farms with deep litter rearing system (6.8%) and lowest in large scale layer farms with cage system (4.8%) (Table 1).

Antemortem and postmortem examination of birds:

Clinical signs suggestive of coccidiosis observed at antemortem examination included unthriftness, rough feathers, soft
### Table 1. Frequency of detection of coccidia oocysts in faecal samples (n=1028).

<table>
<thead>
<tr>
<th>Production system</th>
<th>Rearing system</th>
<th>Number of farms</th>
<th>Samples examined</th>
<th>Positive samples</th>
<th>Percentage positive (CI)</th>
<th>Mean OPG ± SD (CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small scale Pullets</td>
<td>Deep litter</td>
<td>3</td>
<td>90</td>
<td>73</td>
<td>81.1% (71.5-88.6)</td>
<td>1450 ± 4 (1070-1965)</td>
</tr>
<tr>
<td>Large scale Broilers</td>
<td>Deep litter</td>
<td>5</td>
<td>274</td>
<td>220</td>
<td>80.3% (75-84.8)</td>
<td>3687 ± 6 (2925-4645)</td>
</tr>
<tr>
<td>Small scale Broilers</td>
<td>Deep litter</td>
<td>12</td>
<td>317</td>
<td>231</td>
<td>72.9% (67.6-77.7)</td>
<td>2553 ± 7 (1981-3289)</td>
</tr>
<tr>
<td>Large scale Layers</td>
<td>Deep litter</td>
<td>2</td>
<td>11</td>
<td>88</td>
<td>6.8% (3-12.9)</td>
<td>193 ± 2 (148-251)</td>
</tr>
<tr>
<td>Large scale Layers</td>
<td>Cage system</td>
<td>4</td>
<td>22</td>
<td>911</td>
<td>4.8% (2.4-8.4)</td>
<td>305 ± 2 (243-386)</td>
</tr>
</tbody>
</table>

CI = Confidence Interval

### Table 2. Frequency of detection of coccidiosis lesions in intestinal tracts of necropsied birds (n=420).

<table>
<thead>
<tr>
<th>Production System</th>
<th>Number of farms</th>
<th>Birds examined</th>
<th>Birds positive</th>
<th>Clinical coccidiosis</th>
<th>Subclinical coccidiosis</th>
<th>Percentage positive (CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large scale broiler</td>
<td>5</td>
<td>191</td>
<td>92</td>
<td>16/92</td>
<td>76/92</td>
<td>(48.2%) (40.9-55.5)</td>
</tr>
<tr>
<td>Small scale broilers</td>
<td>12</td>
<td>199</td>
<td>94</td>
<td>22/94</td>
<td>72/94</td>
<td>47.2% (40.1-54.4)</td>
</tr>
<tr>
<td>Small scale pullets</td>
<td>2</td>
<td>30</td>
<td>12</td>
<td>4/12</td>
<td>8/12</td>
<td>40% (22.7-59.4)</td>
</tr>
</tbody>
</table>

CI = Confidence Interval
Table 3. Proportions of clinical and subclinical coccidiosis, (n=420).

<table>
<thead>
<tr>
<th>Production system</th>
<th>Age group (weeks)</th>
<th>Number of farms</th>
<th>Samples examined</th>
<th>Positive samples</th>
<th>Clinical coccidiosis</th>
<th>Subclinical coccidiosis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3-4</td>
<td>2</td>
<td>44</td>
<td>24</td>
<td>3/24</td>
<td>21/24</td>
</tr>
<tr>
<td>Large scale</td>
<td>5-6</td>
<td>2</td>
<td>32</td>
<td>10</td>
<td>2/10</td>
<td>8/10</td>
</tr>
<tr>
<td></td>
<td>7-8</td>
<td>4</td>
<td>115</td>
<td>58</td>
<td>11/58</td>
<td>47/58</td>
</tr>
<tr>
<td></td>
<td>3-4</td>
<td>3</td>
<td>47</td>
<td>17</td>
<td>4/17</td>
<td>13/17</td>
</tr>
<tr>
<td>Small scale</td>
<td>5-6</td>
<td>7</td>
<td>115</td>
<td>50</td>
<td>14/50</td>
<td>36/50</td>
</tr>
<tr>
<td></td>
<td>7-9</td>
<td>5</td>
<td>67</td>
<td>39</td>
<td>8/39</td>
<td>31/39</td>
</tr>
</tbody>
</table>
Table 4. Proportions of severe and mild/moderate lesions compared to the occurrence of clinical and subclinical coccidiosis, (n=420).

<table>
<thead>
<tr>
<th>Production system</th>
<th>Samples examined</th>
<th>Positive samples</th>
<th>Severe Lesions (Score 3-4)</th>
<th>Mild/moderate Lesions (Score 1-2)</th>
<th>Clinical coccidiosis</th>
<th>Subclinical coccidiosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large scale</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>broilers</td>
<td>191</td>
<td>92</td>
<td>7/92 (7.6%)</td>
<td>85/92 (92.4%)</td>
<td>16/92 (17.4%)</td>
<td>76/92 (82.6%)</td>
</tr>
<tr>
<td>Small scale</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>broilers</td>
<td>199</td>
<td>94</td>
<td>9/94 (9.6%)</td>
<td>85/94 (90.4%)</td>
<td>22/94 (23.4%)</td>
<td>72/94 (76.6%)</td>
</tr>
<tr>
<td>Small scale</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pullets</td>
<td>30</td>
<td>12</td>
<td>2/12 (16.7%)</td>
<td>10/12 (83.3%)</td>
<td>4/12 (33.3%)</td>
<td>8/12 (66.7%)</td>
</tr>
</tbody>
</table>

Table 5. Distribution of coccidia species in chicken in small scale (n=14) and large scale (n=5) poultry farms.

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of samples</th>
<th>Small scale farms</th>
<th>Species distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eimeria acervulina</td>
<td>68</td>
<td>38/68 (55.9%)</td>
<td>30/68 (44.1%)</td>
</tr>
<tr>
<td>Eimeria necatrix</td>
<td>8</td>
<td>6/8 (75%)</td>
<td>2/8 (25%)</td>
</tr>
<tr>
<td>Eimeria maxima</td>
<td>17</td>
<td>10/17 (58.8%)</td>
<td>7/17 (41.2%)</td>
</tr>
<tr>
<td>Eimeria tenella</td>
<td>65</td>
<td>34/65 (52.3%)</td>
<td>31/65 (47.7%)</td>
</tr>
<tr>
<td>Mixed infections</td>
<td>40</td>
<td>19/40 (47.5%)</td>
<td>21/40 (52.5%)</td>
</tr>
</tbody>
</table>
to watery faeces with mucus or blood. Specific lesions were observed following the opening of the abdominal cavity and systematic examination of the gastrointestinal tracts. Lesions due to coccidiosis were detected in 48.2%, 47.2% and 40% birds which were examined in large scale broiler, small scale broiler and small scale pullet respectively (Table 2).

There was no significant difference (P-value = 0.731) in overall prevalence of coccidiosis among large scale and small scale poultry farms. Only a few cases 17.4%, 23.4% and 33.3% of all positive cases from large scale broiler, small scale broiler and small scale pullet rearing farms, respectively showed clinical signs of coccidiosis (Figure 1). There was no significant difference (P-value = 0.761) in cases of clinical coccidiosis among the different production systems. The frequency of detection of coccidia oocysts was significantly (P-value = 0.048) higher compared to the frequency of detection of coccidia lesions (Figure 2). Cases of clinical coccidiosis were higher, though not statistically significant (P-value = 0.905) in the age group of 5-6 weeks compared to other age groups (Table 3). The proportions of observed severe and mild/moderate lesions compared to the occurrence of clinical and subclinical coccidiosis are shown on Table 4.

**Identification of species of coccidia**

Four *Eimeria* species in the chickens were identified in this study, namely; *Eimeria acervulina, Eimeria tenella, Eimeria maxima* and *Eimeria necatrix*. Mixed infections were also encountered in the different production systems. Though not quantified, the mixed infections recorded were mainly due to *Eimeria acervulina* and *Eimeria tenella*. The proportions of the prevalent species in the study area indicate that *Eimeria acervulina* and *Eimeria tenella* were the most prevalent species whereas *Eimeria maxima* and *Eimeria necatrix* were less prevalent (Table 5). The species were uniformly distributed between the two production systems except for *Eimeria necatrix* which occurred at a relatively higher frequency in small scale farms (75%) as compared to large scale farms (25%).

**Potential risk factors for coccidiosis:**

Potential risk factors for coccidiosis in the surveyed farms included age of birds, production system, flock size, stocking density, amount of moisture in the poultry houses, ventilation systems, equipment quality, level of biosecurity practices and age of the farms.

**Discussion**

The percentages of faecal samples positive for coccidia oocysts were higher compared to the percentages of birds positive for coccidiosis lesions examined at postmortem examination from the same flocks (Figure 2). In this case there were birds shedding coccidia oocysts without having lesions due to coccidiosis. Mean OPG counts for each production system were not directly related to an equivalent level of frequency and severity of the disease in the same farm or production system. One might expect a direct relation to exist based on the fact that coccidiosis results following ingestion of sporulated oocysts present in the environment where birds are kept. But according to our results this is not the case. There was also a
significant variation between clinical and sub-clinical coccidiosis in the different production systems (Figure 1). This finding further supports earlier ones that the occurrence and severity of coccidiosis is not directly related to the shedding and contamination of the environment with coccidia oocysts. Higher percentages of subclinical cases of coccidiosis were obtained compared to clinical cases. This is in agreement with published literature about the course of the disease, especially where control measures such as coccidiostats in feed are used. In such cases coccidia infections are known to take a subclinical course and only a few cases manifest clinical signs of the disease. Similar findings have been reported by Voeten and Jansen, McDougald and Reid and Braunius.

The study also recorded higher percentages of faecal samples positive for coccidia oocysts in broiler and pullet rearing farms compared to layers. This can be explained by the fact that layer farms kept older birds compared to broiler and pullet rearing farms. Waruiru et al. made similar observations on coccidiosis in dairy goats. Coccidiosis in poultry is known to be a disease of young birds. Most layer farms reared their birds in cages, hence birds had no access to coccidia oocysts as they had minimum contacts with chicken faeces. The low levels of coccidia oocysts detected in caged birds could be as a result of mechanical transmission by attendants or these birds might have been reared on litter prior to being caged.

Mean OPG counts recorded for each production system were not directly related to the levels of frequency and severity of the disease. Small scale pullet rearing farms had the lowest mean OPG counts as compared to large scale broiler and small scale broiler farms (Table 1). However they had the highest frequency of clinical cases (Table 2). These results are in contrast with results from previous studies in Ethiopia that reported high percentages of clinical cases of coccidiosis ranging between 54.6% and 80%. It would appear that adopted control measures including improvements in management practices and use of coccidiostats in the feed have been effective.

When the overall prevalence of coccidia infections in the different production systems and among the different age groups of chickens were compared, there was no significant (P-values > 0.05) difference. This can be explained by the effect of management practices particularly with regard to the use of coccidiostats in the feeds. Questionnaire responses showed that all farms examined used coccidiostats in feed from the same manufacturer.

Assessment for potential risk factors for coccidiosis showed that all factors including those considered important such as age of the birds, flock size, stocking density, amount of moisture in litter, levels of biosecurity practices and equipment quality were not associated with the disease. This demonstrated the strong effect of coccidiostats in suppressing occurrence of the disease despite the existence of coccidiosis - promoting factors. Development of immunity might have contributed to the suppression.

Cases of clinical coccidiosis were higher in small scale farms as compared to large scale farms (Table 2), and higher percentages of severe lesions (lesion scores 3-4) were observed in small scale farms as compared to large scale farms (Table 4). On the contrary, the cases of subclinical coccidiosis and cases of mild
Figure 1. Comparison between proportions of clinical coccidiosis (Clin. coc) and subclinical coccidiosis (Sbclin.coc), (n=420).

Figure 2. Comparison between frequency of detection of coccidia oocysts in faecal samples and occurrence of coccidiosis lesions in the gastro-intestinal tracts (GIT) (n=420).
to moderate lesions (lesion scores 1-2) occurred at low frequencies in small scale farms as compared to large scale farms. These differences however, were not significant following statistical analysis. There was no significant (P-values > 0.05) differences between prevalence rates of clinical coccidiosis and severe lesions among the different production systems. The present observation and study however, indicated that management and environmental stress to which birds in small scale farms were exposed especially with regard to stocking densities, ventilation and high moisture levels in the poultry houses were important risk factors.

Higher percentages of cases of clinical coccidiosis in the 5-6 weeks age groups were observed compared to other age groups in all production systems (Table 3). This was because most coccidia infections occur at the age of 3-4 weeks but clinical disease develop one or more weeks later. As a result the peak of clinical disease appears at the age of 5-6 weeks. As age increases to 7-8 weeks, most birds develop immunity which suppresses development of clinical disease. Because of the state of balance between the immunity of the bird and the trickie infection through continuous ingestion of small doses of oocysts, at the age of 7-8 weeks or more the most important form of the disease is subclinical. Reid, Razmi and Kalideri and Braunius made similar observations.

In the present study four species of coccidia in chicken namely, *Eimeria acervulina*, *Eimeria necatrix*, *Eimeria maxima* and *Eimeria tenella* were identified. Although there were variations in the proportions of each species identified, the results are in agreement with previous studies in Ethiopia which attempted species identification. Unlike in the study of Fessesse-work, *Eimeria mivati* was not identified in this study. This may probably be due to management and environmental changes. Furthermore, there are close morphological and biological similarities between *Eimeria acervulina* and *Eimeria mivati* which might have made it difficult to differentiate the two species based on the methods of investigation applied in the current study. Questionnaire responses and observation indicated that, except in one large scale farm and two small scale farms, coccidiosis was not highly ranked as an important cause of losses as it used to be in the past. Most respondents ranked coccidiosis as second or third disease after broiler ascites, colibacillosis or cannibalism in layers. Despite the advances in controlling the disease, cases of subclinical coccidiosis are still significant. Therefore, taking into account the weight loss resulting from subclinical coccidiosis and the high cost of medication, coccidiosis is still an important disease that causes significant economic losses to the poultry industry in the study area.

**Acknowledgements**

The authors would like to thank the Joint Postgraduate Programme of the Addis Ababa University and Freie Universitat Berlin for the financial, material and technical support. We would also like to thank farm authorities and individual poultry farmers for their co-operation in sample collection and answering questionnaires. The material and technical support of the International Livestock Research Institute and the Ethiopian Agricultural Research Organisation is gratefully acknowledged.
References


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SHORT COMMUNICATION

EFFICACIES OF ALBENDAZOLE, LEVAMISOLE AND IVERMECTIN AGAINST GASTRO-INTESTINAL NEMATODES OF SHEEP IN NIGERIA

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Investigations on the efficacies of anthelmintics are few and anthelmintics have been used without efficacy assessments in most farms in Nigeria. There is a recent interest in this area worldwide as reports of anthelmintic resistance (AR) abound in the literature\(^1\)\(^-\)\(^3\), even to the newest broad-spectrum ivermectins.\(^4\)\(^-\)\(^7\). Anthelmintic resistance can be described as a heritable change in the ability of individual parasites to survive the recommended therapeutic dose of an anthelmintic\(^2\). Anthelmintic resistance is thought to exist when there is a greater frequency of individual within a population able to tolerate a given dose of the anthelmintic than those in the same population that respond to the same treatment\(^1\). In the present study, the efficacies of three commonly used anthelmintics against gastrointestinal nematodes were assessed in naturally infected sheep in Ijebu-Igbo, Ogun-state, Nigeria.

In August 1999, a flock of 120 sheep obtained from northwestern Nigeria for fattening purposes were randomly divided into four groups of 30 animals each. Their faecal nematode eggs were identified and enumerated by the modified McMaster technique as previously described\(^8\). The individual faecal egg counts ranged between 900 and 6700 eggs per gram (epg) of faeces. Animals in group A were treated with ivermectin\(^\circ\) (ivermectin, MSD, Holland) at a dose of 0.2mg/kg body weight subcutaneously. Animals in group B were treated orally with albendazole, Concept Pharmaceuticals Ltd., India) at a dose of 7.5mg/kg body weight. Animals in group C were treated orally with Wormcare\(^\circ\) (1.5% levamisole, Sam Pharmaceuticals, Nigeria) at a dose of 7.5mg/kg body weight. Animals in group D were left untreated and acted as the control. Faecal nematode egg counts were repeated 10 days post treatment and the anthelmintic efficacy estimated as previously described\(^9\). The percentage reduction (FECR) was corrected for changes that occurred in the control group by the equation:

\[
\text{FECR} (%) = \left( 1 - \frac{T_2}{T_1} \cdot \frac{C_1}{C_2} \right) \times 100
\]

Where \(T\) and \(C\) are the geometric means for the treated and control groups and subscripts 1 and 2 designate the counts before and after treatment respectively\(^9\).

The overall percentage reductions in faecal nematode egg counts following anthelmintic treatment in the various groups were different. Inverctin and levamisole reduced the mean faecal egg counts by 100% (3127 to 0) and 93.24% (3083 to 243) respectively. However, sheep treated with albendazole had only 65.70% (2787 to 1113) reduction. The untreated control group had mean faecal
egg counts of 2270 and 2643 respectively at Day 0 and Day 10 post treatment.

Anthelmintic resistance (AR) is established if there is less than 90% reduction in the faecal egg output following therapeutically effective anthelmintic. An effective anthelmintic without any AR must therefore reduce the faecal egg count by 90% or more. Anthelmintic resistance against albendazole in sheep was thus established in this study.

The results of this study are in agreement with the report that a subcutaneous injection of 0.2mg/kg body weight of ivermectin caused a 100% reduction in faecal egg counts in naturally infected sheep and goats in Zambia. Also, high resistance to albendazole in goats were reported in Malaysia, while in Zimbabwe, a variable efficacy of levamisole in sheep was reported. In this study however, levamisole had high efficacy against gastro-intestinal nematodes of sheep.

Resistance of trichostrongylids of small ruminants has been shown in Cameroon, Kenya, Tanzania, Zimbabwe and Zambia. In South Africa, AR has become a major problem in sheep farms where surveys indicate that 90% of the farms harboured resistant helminth strains and that on 40% of these strains were resistant to three or more anthelmintic groups.

Rapid emergence of AR in sheep and goat industry across many countries of the world involving gastro-intestinal nematodes has led to widespread interest in this problem. If management is directed at integrated control, that is, the use of both grazing management and strategic anthelmintic treatment against worm populations, the selection towards resistance will be reduced. Grazing management is a valuable strategy that can be adopted in order to reduce the frequency of treatment.

Resistant gastro-intestinal nematodes are unable to migrate from one pasture to another unless they are within a host. Therefore, the manner in which most producers acquire resistant nematodes is by purchasing animals infected by them, thus they select for resistant populations. Purchased animals should be treated with a non-benzimidazole anthelmintic drug and monitored for two weeks before they are put out to graze.

Although the degree of AR in nematode parasites of ruminants in other areas of Nigeria is not known, the results of the present study indicate that AR might be widespread because the animals were obtained from various locations in northwestern Nigeria. Hence there is need for an immediate extensive survey of AR in Nigeria in order to design a strategic control program for nematode parasites and restrict the use of anthelmintics in order to reduce the selection pressure on worm populations.

Acknowledgements

I wish to express my profound gratitude to Alhaji Igi – Egbo who obtained these animals, purchased all the drugs and provided transportation to the laboratory. The technical assistance of Mr. O.O. Ashimolowo of the Department of Veterinary Medicine, University of Ibadan is gratefully acknowledged.

References


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Ticks are a major cause of production losses in antelopes on game ranches in southern Africa\(^1\,^2\). They transmit blood parasites of cattle such as *Theileria parva parva*, *Anaplasma marginale* and Babesia *bigemina* that cause theileriosis, anaplasmosis and babesiosis respectively. The effects of heavy tick burdens on antelopes include tick worry, tick toxicosis, tick-bite abscesses, anemia and metabolic disturbances\(^3\).\(^4\).

The abundance of hosts of different species as occurs on mixed cattle and antelope farming systems results in severe tick infestations due to the availability of suitable hosts for adult and immature ticks\(^4\).

Between August 1999 and February 2001, ticks were collected from eland (*Taurotragus oryx*), sable antelope (*Hippotragus niger*), common reedbuck (*Reduncia arundinum*), impala (*Aepyceros melampus*) and tsessebe (*Damaliscus lunatus*), on five farms around Harare that rear cattle and antelopes together. The ticks were collected from all over the body including from inside the ears, under the tail and preserved in labelled bottles with 70\% alcohol. Identification of the ticks with respect to species and stage of development was done using the stereoscopic microscope. The characteristics of the farms including the number of antelope species are shown in Table 1.

Seven ixodid tick species namely; *Rhipicephalus appendiculatus*, *Rhipicephalus evertsi evertsi*, *Rhipicephalus simus*, *Rhipicephalus compositus*, *Hyalomma marginatum rufipes*, *Hyalomma truncatum* and *Boophilus decoloratus* were recovered from the five antelope species. The tick species recovered a nd the number of immature and adult tick stages on individual animals are shown in Table 2. *Rhipicephalus* tick species were present on all antelope species. *Rhipicephalus appendiculatus* and *R. evertsi evertsi* were the most common and abundant ticks infesting the antelopes.

The eland, sable and impala harboured predominantly adult ticks, whilst the common reedbuck and two apparently sick tsessebe harboured mainly nymphs and larvae. The highest relative tick burdens were present on the

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\(^1\) Corresponding Author: E-mail smukaratirwa@esanet.zw.
<table>
<thead>
<tr>
<th>Farm</th>
<th>Size (ha)</th>
<th>Cattle/antelope</th>
<th>No. of antelope species</th>
<th>Stocking density of cattle/antelope</th>
<th>Grazer/mixed antelope</th>
<th>Browser antelope (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imire</td>
<td>3000</td>
<td>1:1</td>
<td>12</td>
<td>11 su/4 ha</td>
<td>93</td>
<td>7</td>
</tr>
<tr>
<td>Rapako</td>
<td>1200</td>
<td>3:1</td>
<td>7</td>
<td>Unknown</td>
<td>68</td>
<td>32</td>
</tr>
<tr>
<td>Chiparawe</td>
<td>1200</td>
<td>1:1</td>
<td>8</td>
<td>11 su/9 ha</td>
<td>97</td>
<td>3</td>
</tr>
<tr>
<td>Chimbi</td>
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<td>6</td>
<td>Unknown</td>
<td>71</td>
<td>29</td>
</tr>
<tr>
<td>Mona</td>
<td>1500</td>
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<td>11</td>
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<td>Host</td>
<td>Location and date</td>
<td>Tick species</td>
<td>Number of tick stages recovered</td>
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</tr>
<tr>
<td>--------------</td>
<td>-------------------</td>
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<td></td>
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</tr>
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<tr>
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<td>R. appendiculatus</td>
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<td>(adult)</td>
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<td>8</td>
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impala, eland and tsessebe.

The apparently good annual rainfall received in the study area during the study period and the tall grasses available on the farms provided ideal conditions for the development and survival of the stages of *R. appendiculants*, hence the high prevalence of this tick species on the antelopes. The recovery of *R. appendiculants* from the reedbuck, eland, impala and tsessebe confirms its wide host range as reported by Zieger et al.\(^3\). *Rhipicephalus appendiculatus* ticks have also been reported on eland, tsessebe, impala, reedbuck and sable antelope in Zimbabwe.\(^5,6\) Rodents have been reported to be efficient hosts of the immature stages of *R. simus*\(^7\) and the low prevalence in this study can be attributed to the low rodent and antelope contact on pastures and the absence of the preferred monogastric hosts such as the carnivores and warthogs.\(^8,9\) *Rhipicephalus compositus* is considered a tick species of little economic importance with respect to its role as vector of tick-borne diseases in animals.

The presence of eland and zebra on all the farms explains the relative high prevalence of *R. evertsi evertsi*, as these animals are the preferred hosts.\(^10,11\) *Rhipicephalus evertsi evertsi* has been reported in other studies as infesting the impala, tsessebe and reedbuck.\(^7\) *Boophilus decoloratus* is primarily a tick of larger herbivores such as cattle.\(^8\) The recovery of this tick on the eland in the present study was therefore not unexpected. However, *B. decoloratus* was also present on two impala. Scrub hares (*Lepus saxatilis*) are the ideal hosts for immature stages of *H. m. rufipes* and *H. truncatum*\(^12,13\) and eland are preferred hosts of the mature ticks,\(^11\) hence the recovery of adult ticks of these species from eland. The two sick tsessebe harboured predominantly immature stages of ticks because of their recumbent tendency and the proximity to larvae and nymphs on the ground and possibly the impaired immune system. The tsessebe calf harboured only immature stages of *Rhipicephalus species*, which confirms findings by other workers that young and small antelope are good hosts for immature stages of ticks.

Three tick species that were identified on antelopes, that is, *R. appendiculatus*, *R. evertsi evertsi*, and *B. decoloratus* are of major economic importance in Zimbabwe as vectors of theileriosis, anaplasmosis and babesiosis.\(^14\) The recovery of these ticks that are commonly found on cattle. The cross-transmission of ticks between cattle and antelopes poses a challenge in the control of ticks and tick-borne diseases in cattle on these farms as antelopes have been reported to carry subclinical tick-borne infections due to *Babesia sp.*, *Theileria sp.* and *Anaplasma sp.*.\(^15,16\) Antelopes on mixed farms are therefore potential reservoir hosts for ticks and tick-borne diseases of cattle. Adult ticks seem to prefer the larger antelope species such as the sable antelope and eland whilst the immature stages prefer the smaller antelopes, which concurs with similar findings by Horak.\(^4\) Despite its smaller size, the impala harboured mainly the adult tick species.

**Acknowledgements**

The authors wish to acknowledge the assistance of Mr. Mazhouw of the Central Veterinary Laboratories wish the identification of the ticks and the Director General for International Cooperation, Belgium, for financial assistance.
Ixodid ticks recovered from the Eland (Taurotragus Oryx), Sable Antelope (Hippotragus Niger), Common Reedbuck (Redunca Arundium) Impala (Aepyceros Melampus) and Tsessebe (Damaliscus Lunatus).

References


Received for publication on 18th March, 2002
SHORT COMMUNICATION

THE PREVALENCE OF ANTIBODIES TO FOWL TYPHOID IN INDIGENOUS NIGERIAN CHICKEN (Gallus gallus domesticus).

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Nigerian indigenous chickens have been shown to outnumber the commercial chickens by a ratio of 8:1 and they constitute over 70% of Nigerian poultry population which was placed at 134 million\textsuperscript{1,2}.

Various studies conducted on important diseases of poultry have shown that indigenous chickens play a considerable role in the epidemiology of poultry disease such as Newcastle disease\textsuperscript{3}, infectious bursal disease\textsuperscript{4}, brucellosis\textsuperscript{5} and salmonellosis\textsuperscript{6,7}.

Fowl typhoid is a bacterial septicaemic disease of adult birds caused by *Salmonella gallinarum* subsp. *enterica serova gallinarum* biovar *gallinarum* denoted as *S. gallinarum*. It is an endemic disease of commercial poultry in Nigeria\textsuperscript{8} and other parts of Africa including Libya\textsuperscript{9}, Tanzania\textsuperscript{7,10}, Morocco\textsuperscript{11} and Somali Republic\textsuperscript{12}. Fowl typhoid has been associated with a morbidity of 50-70% and a mortality of 10-18% in commercial birds in Nigeria\textsuperscript{13}. However, there has been no report of the clinical disease in local chickens which are not normally vaccinated in free range management.

In commercial flocks, there has been reports of other salmonella infections, mainly *s. pullorum* disease\textsuperscript{5,14} and fowl paratyphoid\textsuperscript{15} while a chronic fowl typhoid infection has also been reported in commercial farms in Nigeria\textsuperscript{13,16}.

Studies of the susceptibility and humoral immune response of local and commercial chickens to fowl typhoid showed that both groups are susceptible\textsuperscript{17,18,19} but the commercial birds showed more severe clinical signs and higher antibody response\textsuperscript{19} while an earlier report showed that Nigerian indigineous chickens are better immune responders than exotic chickens\textsuperscript{18}, an observation that has been attributed to different rates of immune response among indigenous chickens\textsuperscript{20}.

In most of the above reports, serodiagnosis of fowl typhoid was based on slide agglutination, serum rapid plate agglutination (SRPAT) and the serum agglutination test. However, comparative studies of the ELISA with other serodiagnostic techniques showed that the ELISA is more sensitive than the serum agglutination test\textsuperscript{21}, and is best suited for mass screening in epidemiological studies.

There has been no previous report of the use of the ELISA in the serodiagnosis of fowl typhoid in the indigenous chickens as compared to its use in commercial flock\textsuperscript{22,23}. This paper describes the results of a serological survey to determine the prevalence of fowl typhoid antibodies in the Nigerian indigenous chicken with the use of ELISA technique.

This study focused on three communities in Ibadan metropolis:
University, Agbowo and Oremeji communities with high, medium and low commercial poultry production respectively. A total of 154 apparently healthy adult indigenous chicken reared under free range management system in 38 flocks of flock size 8-20 birds were sampled. One out of every four birds was randomly selected per household and held via jugular venopuncture. Test sera obtained from the clotted blood were heat inactivated at 56°C for 30 minutes and stored at -20°C until analysed. All the chicken had history of any vaccination.

Some of the owners objected to the sample collection from their birds, especially in Agbowo and Oremeji communities. This was responsible for the relative variation in the sample size.

The ELISA procedure was conducted essentially by adaptation of the method described earlier for infectious bronchitis with some modifications. The dried fowl typhoid vaccine (DFT) was used as antigen in the ELISA test. The bacterin produced from local isolates of Salmonella gallinarum, was obtained from the Nigerian Veterinary Research Institute, Vom and used at protein concentration of 25.0mg/ml following the determination of the bacterial protein concentration as described earlier.

The positive test samples were those with optical density (OD) values equal to or above 1.5 times the OD of the negative control. The antibody levels were directly related to the OD values of the individual samples tested. A prevalence rate of 40.6% (26/64) was obtained for the University community while 20% each, was obtained for Agbowo (10/50) and Oremeji (8/40) communities. The prevalence of FT antibodies among 154 indigenous chickens screened in Ibadan was 28.6%.

The mean optical density values for positive reactors were 0.140±0.048 for the University community; 0.119±0.032 for Agbowo, and 0.128±0.025 for Oremeji communities respectively, while the overall mean OD was 0.135±0.023.

The flock size observed in this study conforms with previous report of the range of flock size of the local chicken. The overall prevalence of FT antibodies in this study was remarkably higher than the 0% obtained among local chicken flocks in the same area with the use of rapid blood agglutination test previously reported, and 8% reported with bacterial isolation technique. The higher overall prevalence of 28.65% recorded in this study may be attributed to the higher sensitivity of ELISA method. Although a comparative sensitivity study of the ELISA with rapid blood agglutination test was not conducted in this study, observations of other workers showed that ELISA is more sensitive than agglutination test as a serodiagnostic tool.

The variation in the prevalence of FT antibodies in the three communities studied may be associated with the level of poultry production in these areas. The birds sampled in the University community, which maintains a high poultry production due to teaching and research farm, had higher antibody prevalence probably due to constant exposure to the bacteria through outbreaks in exotic breeds, since commercial poultry have been shown to have high prevalence of FT. It was noteworthy that the indigenous birds in this group were sampled from the community around the farm and with no direct control of movement of the local birds into the commercial farm premises.

Since there is no routine vaccination against FT in indigenous chicken in Nigeria, the antibodies observed in these birds would be due to field challenge. The absence of clinical disease in these birds therefore suggests the possibility of carrier status as previously advocated, and could serve as hosts for perpetuation of FT.
outbreaks in the more susceptible exotic breeds 17 especially when adequate contact prevention devices are not implemented in commercial farms. Previous studies have shown that Salmonella gallinarum is less invasive in local than in the exotic chicken 19.

This finding is also of epidemiological and public health importance, since infected local chickens may serve a source of infection to man 11. Although it was not possible to ascertain the source of infection in the indigenous chicken, the birds were known to roam freely scavenging for food 3, and could have been exposed to infected formites in the environment as has been reported for other salmonella infections 27.

This study showed that there is considerably higher level of FT activity among the free range Nigerian indigenous chicken population than previously reported 14 and these could be a source of maintenance of the organism in the environment. An effective national control for FT should therefore take into consideration the role of the local chicken in the epidemiology of the disease.

Acknowledgements

The authors are grateful to the EEC Trypanosomosis project for providing the facilities for this work.

References


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SHORT COMMUNICATION

EFFECT OF SEX ON THE BLOOD PROFILES OF THE NIGERIAN LOCAL DUCK
(Anas platyrhynchos)

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The normal haematological and plasma biochemical values were determined in the male and female Nigerian local duck (Anas platyrhynchos). There were no significant sex differences in the erythrocyte and leucocyte values. There were also no sexual dimorphism in the plasma levels of electrolytes, proteins, metabolites, lipids and enzymes of this bird.

The current population of ducks in Nigeria stands at about 11.79 million\(^1\). The majority of these ducks are the Nigerian local type reared in villages using the extensive management system.

There are many reports on the haematological and plasma biochemical values of the exotic breeds of ducks\(^2,3,4,5,6,7,8,9,10,11\) However, there is a paucity of knowledge on the blood profile of the Nigerian local duck. There are two reports only on the normal haematological values of the Nigerian local duck\(^12,13\). This study, presents the haematological and plasma biochemistry parameters in the Nigerian local duck.

Twenty-eight (13 males and 15 females) apparently healthy adult Nigerian local ducks were used in this study. They were purchased from a local market in Ibadan, Nigeria, from where they were transferred to the deep litter pen belonging to the Duck Research Unit of the Faculty of Veterinary Medicine, University of Ibadan. They were fed commercially prepared grower’s mash (14.5% protein, 4.8% fat, 7.2% fibre, 0.8% calcium, produced by Bendel feeds and flour mill Ltd., Benin, Edo State, Nigeria). Water was supplied ad libitum. They were treated against nematodes with piperazine hydrochloride (Wormazine\(^\circ\), Alfansan International BV 3440 AB woorden, Holland). at lg/liter of water. The birds were acclimatized to the new environment of the Duck Research Unit for 21 days before the commencement of this study.

Blood was collected from the juglar vein of each bird into bottles containing ethylene diamine tetraacetic acid (EDTA) (2mg/ml of blood as anticoagulant). The Red Blood Cells (RBC) and White Blood Cells (WBC) were counted with the use of the haemocytometer. The packed cell volume was determined using the microhaematocrit method. Haemoglobin (Hb) concentration was measured by the cyanmethaemoglobin method. From the data generated on the Hb, RBC and PCV, the Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin concen-tration (MCHC) were calculated\(^14\). Blood smears were stained with Giemsa stain for differential WBC counts.

Blood was centrifuged at 3000g for 10 minutes to obtain plasma to establish the

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levels of electrolytes, enzymes, protein, metabolites and lipids. Sodium and potassium concentrations of the plasma were determined by standard flame photometry and chloride by the method of Schales and Schales. Plasma levels of bicarbonate, calcium and triglycerides were determined by the method described by Toro and Ackermann. Inorganic phosphate was determined by the method of Gomori. Cholesterol was estimated as described by Pesce and Boudurain.

Total protein was determined by the Biuret method of Reinhold and albumin by the method described by Doumas. Globulin amount was calculated by subtracting albumin from total protein. Urea and creatinine were determined according to the method of Harrison. Uric acid was determined by the method of Rosenthal. Activities of aspartate aminotransaminase (AST) and alanine aminotransaminase (ALT) were determined colorimetrically according to Mohun and Cook. Alkaline phosphatase (ALP) was determined according to the method of King and Armstrong. The results were statistically evaluate using the Student's t-test.

The values of RBC, PVC, Hb, MCH, MCHC and MCV in the male and female Nigerian local duck are shown in Table 1. These values do not differ in the two sexes.

Table 2 shows the total and differential leucocyte counts in the male and female Nigeria local duck. The WBC: lymphocyte, heterophils, eosinophils and monocytes counts are similar in the male and female ducks.

Table 3 presents the plasma biochemical values in the male and female Nigerian duck. The values of plasma electrolyte (Na, K, Cl, HCO3, Ca and inorganic PO4), plasma protein (albumin, globulin, albumin/globulin ratio), plasma metabolites (Urea, creatinine and Uric acid), plasma enzyme (AST, ALT and ALP), and plasma lipids (cholesterol and triglycerides) were similar in the two sexes of the Nigerian local duck.

The similar RBC, Hb, PCV, MCV, MCHC and MCH values in the adult male and female Nigerian local duck in the present study (Table 1) agrees with the findings in earlier studies in the ring-neck pheasants, the canvassback duck, the wood duck, and the Nigerian local duck, in which no sex
differences were obtained in the erythrocyte values studied.

However, the role of androgens in increasing the erythrocyte values in the birds have been reported. This is probably why the observation of the present study disagrees with earlier findings in the domestic fowl, Japanese quail, geese, guinea fowl and the white pekin duck in which the erythrocyte values were reported to be higher in the male than female. It appears the influence of androgens is limited on erythropoiesis in the male Nigerian duck.

The total WBC: lymphocyte, heterophil, monocyte, and eosinophil counts were similar in the male and female Nigerian local duck in the present study (Table 2). This absence of sexual dimorphism in the male and female Nigerian local duck with reference to the total and differential leucocyte counts is similar to what was observed in the black duck and the wood duck. There were also no significant sex differences in the total and differential leucocyte values in the Nigerian duck and Japanese quail.

The plasma levels of total protein, albumin, globulin and albumin/globulin ratio were similar in the male and female Nigerian local duck (Table 2). This finding is similar to observation made in the black duck (Anas superciliosa) in which these ratios were similar in the male and female. The plasma protein were also similar in the male and female domestic fowl. However, the total plasma protein was found to be higher in the female domestic than in the male Japanese quail. Oywale also observed that the female guinea-fowl had higher plasma total protein, albumin and globulin than the male guinea-fowl. It seems the higher plasma total protein in the female than Japanese quail and the higher total plasma proteins in the female than male guinea-fowls may be due to the influence of estrogen in increasing the plasma protein in the female birds.

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<td>LYMHOCYTES (X 10^9/L)</td>
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<td>1.92 ± 0.57</td>
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<tr>
<td>HETEROPHILS (X 10^9/L)</td>
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<tr>
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<td>MONOCYTES (X 10^9/L)</td>
<td>0.10 ± 0.07</td>
<td>0.08 ± 0.09</td>
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Number of birds in parentheses

* Value expressed as a percentage of Total WBC count.
<table>
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<tr>
<th>Parameters</th>
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<th>Females (n)</th>
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<td>3.03 ± 0.33(12)</td>
<td>3.02 ± 0.66(9)</td>
</tr>
<tr>
<td>Ast (i.u/l)</td>
<td>34.44 ± 4.56(9)</td>
<td>39.83 ± 10.65(6)</td>
</tr>
<tr>
<td>Alt (i.u/l)</td>
<td>26.00 ± 4.92(9)</td>
<td>26.33 ± 8.52(6)</td>
</tr>
<tr>
<td>Alp (i.u/l)</td>
<td>138.22 ± 17.73(9)</td>
<td>154.83 ± 39.01(6)</td>
</tr>
<tr>
<td>Cholesterol (mg/dl)</td>
<td>118.25 ± 18.11(12)</td>
<td>120.56 ± 20.39(9)</td>
</tr>
<tr>
<td>Triglycerides (g/dl)</td>
<td>93.25 ± 21.24(12)</td>
<td>94.22 ± 23.11(9)</td>
</tr>
</tbody>
</table>

In the present study the plasma levels of AST, ALT and ALP were similar in the male and female Nigerian local duck (Table 3). Similar observation was reported in the black duck, in which there were no sex differences in the sera levels of AST, ALT and ALP. Bell however reported a higher ALP activity of the plasma of the laying domestic hen than the non-laying hen presumably because of increased osteoblastic activity in an effort to replace lost bone cells resulting from egg shell formation. However, in the present study only one female duck was laying eggs and this perhaps is why the ALP values were similar in male and female Nigerian duck.

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References


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

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
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