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# BULLETIN OF ANIMAL HEALTH AND PRODUCTION IN AFRICA

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PREVALENCE OF PARASITIC INFECTIONS IN SMALL RUMINANTS IN A PASTORAL COMMUNITY IN NAROK DISTRICT, KENYA.

J.O. WESONGAH\textsuperscript{1*}, J. CHEMULITI\textsuperscript{1}, F.D. WESONGA\textsuperscript{2}, K. WANJALA\textsuperscript{1}, L. MUNGA\textsuperscript{1}, P. NGARE\textsuperscript{1} and G.A. MURILLA\textsuperscript{1}.

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PREVALENCE DES INFECTIONS PARASITAIRE CHEZ LES PETITS RUMINANTS DANS UNE COMMUNAUTE PASTORALE DU DISTRICT DE NAROK AU KENYA

Résumé
Une étude transversale a été effectuée dans deux villages (Emorjoi et Ngoswani) au ranch collectif de Lemek et dans un village (Enkoje) au ranch collectif de Koyaki dans le district de Narok pour enquêter sur les infections parasitaires chez les petits ruminants. Des prélèvements de sang et des échantillons de matières fécales étaient recueillis de 150 moutons et 150 chèvres pendant la saison des pluies (mai/juin) et la saison sèche (août/septembre), puis analysés à l'aide de différentes méthodes parasitologiques. Les résultats ont montré que les parasites qui infectent les petits ruminants dans la région étaient les helminthes, Cowdria ruminantium, les tiques et les trypanosomes. Les espèces de nématodes les plus prévalentes identifiées étaient les strongyloides et les strongyles que l'on trouve chez la plupart des animaux. Le taux d'animaux ayant au moins un ou davantage d'œufs d'helminthe pendant la saison des pluies était de 36% (54) chez les moutons et 52% (78) chez les chèvres respectivement avant le déparrasitage avec le Nilzan plus (1,5% de levamisole + hydrochlore de refoxanide). Environ deux mois après le déparrasitage, ce taux est descendu à 18% (27) et 24,6% (37) chez les moutons et les chèvres respectivement durant la saison sèche. Pendant la saison des pluies, le taux de prévalence globale des trypanosomes chez les moutons et les chèvres était de 1,3% (2) et 4,6% (7) respectivement et baissait considérablement à 0% (0 chèvre) (P<0,05) puis augmentait à 2% (3 moutons) pendant la saison sèche, mais cette augmentation n'était pas significative (P>0,05). Le taux de prévalence globale de la cowdriose était beaucoup plus élevé (P<0,05) chez les moutons (69%, 101) que chez les chèvres (47%, 70) durant la saison des pluies. On a constaté des résultats similaires pour les nombres de tiques. La pression glosinaire enregistrée pendant la période d'observation variait entre 0 et 31,1 mouches/pièce/jour. En conclusion, cette étude recommande le déparrasitage stratégique 3 à 4 semaines avant les pluies et un programme efficace de lutte contre les tiques qui consiste en la pulvérisation des animaux au moins une fois par quinzaine en plus des traitements individuels pour le contrôle de la trypanosomose.

Mots-clés: Trypanosomose, helminthose, cowdriose, petits ruminants.

Summary
A cross-sectional study was carried out in two villages (Emorjoi and Ngoswani) in Lemek group ranch and one village (Enkoje) situated in Koyaki group ranch in Narok District to investigate parasitic infections in small ruminants. Blood and faecal samples were collected from 150 sheep and an equal number of goats during wet season (May-June) and dry season (August-September) and analyzed using different parasitological methods. The findings showed that parasites infecting small ruminants in the area were helminthes, Cowdria ruminantium, ticks and trypanosomes. The most prevalent genera of nematodes identified were Strongyles, which usually occurred concurrently in most animals. The percentage of animals with at least one or more helminth eggs detected during the wet season in sheep and goats was 36% (54) and 52% (78) respectively before deworming with Nilzan plus (1.5% levamisole plus refoxanide hydrochloride). Approximately two months after deworming the animals, this percentage of animals declined to 18% (27) and 24.6% (37) in sheep and goats respectively during the dry season. During the wet season the overall trypanosomise prevalence in sheep and goats was 1.3% (2) and 4.6% (7) respectively and decreased significantly to 0% (0, goats) (P<0.05) and increased to 2% (3 sheep) during the dry season but this increase was not significant (P<0.05). The overall prevalence of heartwater was significantly higher (P<0.05) in sheep (69%, 101) than in goats (47%, 70) during the wet season. Similar findings were observed for the tick numbers. The tsetse challenge recorded during the study period ranged from (0-31.1 fly per trap per day (FTD)). In conclusion this study recommends strategic deworming 3-4 weeks into the rains and a good tick control program of spraying the animals at least once every two weeks and individual treatments for trypanosomosis.

Keywords: Trypanosomosis, Helminthosis, Heartwater, Small ruminants.

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Introduction

Sheep and goats are mainly found in arid and semi-arid areas of sub-Saharan Africa. They play vital role in rural economies through the provision of meat, milk, household income, manure and skin. Compared to cattle and camels, sheep and goats contribute a larger proportion of readily available meat in the diets of pastoralists. They have been estimated to provide up to 30% of the meat and 15% of the milk supplies in sub-Saharan Africa where they thrive in wide range of ecological regions often in conditions too harsh for the beneficial rearing of cattle. Small ruminants have also been reported to survive better under drought conditions than cattle due to their low body mass and low metabolic requirements, which minimizes their water requirements and maintenance needs in arid and semi-arid areas. The frequent droughts and large tsetse infested areas in sub-Saharan Africa necessitates keeping of more small ruminants in order to supplement cattle production.

Chemotherapy is the most common method used for controlling parasitic diseases such as trypanosomosis and gastrointestinal helminthosis, which are a major hindrance to the development of the livestock industry. However, frequent use of veterinary drugs in livestock production has been reported to lead to the development of drug resistance under natural conditions. Small ruminants unlike cattle have been reported to be less susceptible to trypanosomosis so they are treated less frequently or do not require trypanocidal treatment. Studies carried out on the epidemiology of trypanosomosis in sheep and goats in Kenya under ranch and Maasai pastoral management systems indicate differences in susceptibility between sheep and goats and between local and exotic breeds under different production systems. A cross sectional study carried out to quantify the production and constraints of sheep and goats under traditional Maasai pastoral management in Kajiado District, indicated that the main disease control measures undertaken by the pastoralists were chemotherapy and avoidance of areas associated with high disease transmission. Another similar field study was carried out by Griffin and Allonby, on the economic effects of trypanocidal drugs (Isometamidium chloride, Quinapyramine and Diminazene aceturate) in Makueni District, Kenya. The findings of this study indicated that prophylactic treatment, coupled with other permanent methods of controlling the diseases, such as bush clearing would have an important beneficial effect on the productivity of sheep and goats in the areas, even when tsetse challenge is low.

Narok District, a semi-arid area of Kenya, is endemic for trypanosomosis and other livestock diseases such as helminthosis (Narok District Development Plan, 2000). The main economic activity in the district is livestock production and tourism. Livestock population in Narok District is estimated at 1,250,258 thousand heads of which, 45% are sheep, 10% are goats and the rest are cattle. It is anticipated that improving their productivity by controlling livestock diseases will inevitably alleviate the prevailing poverty through increased household incomes. There is no objective information on disease prevalence and control measures undertaken in this area. The present study was carried out in an attempt to address the identified gaps in knowledge on small ruminant production in Narok District, Kenya.

Materials and Methods

Study sites

The study was carried out in three randomly selected villages (Emorijoi, Ngoswani and Enkoje) situated in two group ranches
Prevalence of parasitic infections in small ruminants in a pastoral community in Narok District, Kenya.

Lemek and Koyaki in Narok District, Kenya. The two group ranches lies approximately between latitude 1° 00' 2° 00' South and longitude 34° 45' and 35° 00' East. The area covers about 6,000km² and borders Tanzania in the South, Siria escarpment to the West, Loita plains and hills to the East and Siana hills to the South-East. The area can be divided into 3 Eco-units based on the biography and climate which includes Mara Reserve, Siana (south-east of the reserve) and Loita (north reserve). During the study period (March to December 2003) the temperature recorded ranged from 13°C to 33°C while the annual rainfall was approximately 554mm.

Ten farmers were conveniently selected from each of two villages Emorijoi and Ngoswani because they participated in a previous study involving cattle. Five farmers were purposively selected from Enkoje village due to the high tsetse challenge recorded in the area.

Experimental animals

Ten sheep and an equal number of goats were randomly selected from each of the fifteen farmers. Each farmer had approximately 120 small ruminants. The total number of experimental animals selected was 300 (150 sheep and 150 goats).

The experimental animals selected were of indigenous breeds. The goats consisted of Galla and Small East Africa breeds while the sheep consisted of Black Head Somali and Red Maasai breeds. The small ruminants selected consisted of 143 females (135 adults and 8 lambs) and 157 males (146 adults, 1 lamb and 10 kids). All the experimental animals were ear-tagged for identification. The experimental animals were grazed near the homesteads while the cattle were grazed far away from the homesteads. During sampling, all the experimental animals were clinically examined and weighed using a weighing balance.

All the experimental animals were dewormed with Nilzan plus® (1.5% levamisole plus Refoxanide hydrochloride-Levafas, Coopers (Kenya) Ltd. Laboratories) at a dose per drug of 7.5mg/kg body weight during the wet season. Animals found to be positive for trypanosomes were treated with diminazene aceturate at 7mg/kg body weight on the same day of sampling.

Sampling techniques/site visits

A farmer selection visit was first made in April 2003 followed by study visits to all the three study sites on a seasonal basis (once during the wet season and once during the dry season) giving three visits per homestead.

For each visit, animals in the same herds were bled. Blood samples for sera were collected aseptically by jugular venipuncture into plain vacutainer tubes (Becto-Dickinson) from all the experimental animals. Blood was also collected into heparinised capillary tubes for parasitaemia and PCV determination.

Feecal samples were collected from all the experimental animals early in the morning. The animals were sampled at the same time of the day and a large sample size was used to reduce the variation usually observed in faecal egg counts (FEC). The method used in this study to determine the FEC was MacMaster salt floatation technique.

Tick sampling was done once during the wet season for Emorijoi, Ngoswani and Enkoje villages. All the experimental animals were sampled for ticks by counting and identifying the type of ticks on the whole body using the body (B), tail (T), leg (L) and head (H) tick count method.

Diagnosis of trypanosomes

Buffy coat concentration method was used to detect trypanosome infections while haematocrit centrifugation technique was
used for PCV determination. Giemsa stained thin blood smears were used for identification of different trypanosome species. Thick and thin blood smears were prepared on glass slides for observation for haemoparasites.

**Serum preparation and IB ELISA**

The blood was left to clot at room temperature for 4 hours followed by storage overnight at +4°C. The following day it was centrifuged at 1200 x g for 30 minutes, serum was separated and stored in aliquots of 2 ml at -20°C. The sera was then analyzed for antibody against *C. ruminantium* using the indirect map (major antigenic protein) IB ELISA.

**Tsetse challenge**

Tsetse challenge was monitored monthly by the KARI-TRC entomology team as a routine due to the different trypanosomosis experiments that were ongoing in the area of study. This was done using biconical traps set once a month in the areas where animals grazed. For the present study the tsetse challenge reported was recorded from March to September, 2003.

**Results**

**Tsetse challenge**

The tsetse species identified in the 3 villages were mainly *Glossina swynnertonii* and *G. pallidipes*. The tsetse challenge was recorded as Fly per trap per day (FTD) and ranged from (0-31.1) with the highest being 31.1 recorded in August in Enkoje village.

**Prevalence of trypanosome**

Table 1 shows the overall trypanosome prevalence recorded in sheep and goats during the wet and dry seasons in the 3 villages.

The overall trypanosome prevalence recorded in goats during the wet season was 4.6% (7) and 0% (0) during the dry season in the three villages. In Enkoje village the point prevalence of trypanosomes recorded

<table>
<thead>
<tr>
<th>Group ranch</th>
<th>Village</th>
<th>Species and sample size</th>
<th>Mean PCV ±SD</th>
<th>No. +ve for trypanosomes wet season</th>
<th>No. +ve for trypanosomes dry season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lemek</td>
<td>Emorjoi</td>
<td>Goat (60)</td>
<td>28.3±3.7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sheep(58)</td>
<td>29.9±4.8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Ngosani</td>
<td>Goat(40)</td>
<td>30.6±5.1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sheep(39)</td>
<td>32.0±4.5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Koyaki</td>
<td>Enkoje</td>
<td>Goat(50)</td>
<td>24±3.0</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sheep(50)</td>
<td>27.4±3.7</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>
in goats was 14% (7) in the wet season and 0% (0) during the dry season. In Emorijoi and Ngoswani villages no trypanosome infections were detected in goats throughout the study period.

The overall trypanosome prevalence in sheep was 1.3% (2/150) during the wet season and increased to 2% (3/150) during the dry season. This increase in trypanosome prevalence in sheep was not statistically significant (P>0.05).

In Enkoje village the point prevalence of trypanosomes recorded in sheep was 105 (5) in the wet season and 6% (3) during the dry season. Similar to goats, no trypanosome infections were detected in sheep in Emorijoi and Ngoswani villages (Table 1).

The trypanosome species identified in Enkoje village were *Trypanosoma congolense* (58.3%, 7) and *T. vivax* (41.7%, 5) in the two animal species during the two seasons. The mean PCV for sheep and goats where trypanosomes were found were lower but this difference was not significant (P>0.05).

### Helminthosis

Table 2 shows the results of the analysis of samples for helminth eggs. The overall percentage of goats with at least one or more helminth eggs 52% (78). The percentage of goats with epg equal to or higher than 1000 in the three villages were Emorijoi 19% (11) Ngoswani 6% (2) and Enkoje 4.4% (4) before deworming with (Nilzan plus). The percentages declined to 2% in Enkoje village and to zero in the other 2 villages approximately two months after deworming. The percentage of coccidia recorded in goats was 33.5%.

The overall percentage of sheep with one or more helminth eggs was 36% (54). The percentage of sheep with epg equal to or higher than 1000 in the three villages were 22% (12) in Emorijoi, 12.5% (5) Ngoswani and 3% (3) in Enkoje before deworming. The percentages declined to less than 7% in all the 3 villages after deworming. The prevalence of coccidia recorded was 30%.

The most prevalent genera of nematodes found infecting the two animal spe-

### Table 2: Percentages of goats and sheep with epg equal or higher than 1000 from three villages in Narok District before and after deworming.

<table>
<thead>
<tr>
<th>Group ranch</th>
<th>Village</th>
<th>Species and sample size</th>
<th>Before deworming (%)</th>
<th>After deworming (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lemek</td>
<td>Emorijoi</td>
<td>Goat (11)</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sheep (12)</td>
<td>22</td>
<td>&lt;7</td>
</tr>
<tr>
<td></td>
<td>Ngosani</td>
<td>Goat (2)</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sheep (5)</td>
<td>12.5</td>
<td>&lt;7</td>
</tr>
<tr>
<td>Koyaki</td>
<td>Enkoje</td>
<td>Goat (4)</td>
<td>4.4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sheep (3)</td>
<td>3</td>
<td>&lt;7</td>
</tr>
</tbody>
</table>
Table 3: Tick counts and heartwater prevalence in sheep and goats recorded in three different villages in Narok District.

<table>
<thead>
<tr>
<th>Group ranch</th>
<th>Village</th>
<th>Animal species</th>
<th>Size sampled</th>
<th>Season</th>
<th>Mean tick counts</th>
<th>Total ticks</th>
<th>Heartwater prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lemek</td>
<td>Emorijoi</td>
<td>Goat</td>
<td>59</td>
<td>dry season</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>60</td>
<td>wet season</td>
<td>10</td>
<td>625</td>
<td>52.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sheep</td>
<td>53</td>
<td>dry season</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>60</td>
<td>wet season</td>
<td>14</td>
<td>854</td>
<td>62%</td>
</tr>
<tr>
<td>Ngosani</td>
<td>Goat</td>
<td>-</td>
<td>40</td>
<td>dry season</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sheep</td>
<td>-</td>
<td>wet season</td>
<td>2</td>
<td>71</td>
<td>42.5%</td>
</tr>
<tr>
<td>Koyaki</td>
<td>Enkoje</td>
<td>Goat</td>
<td>50</td>
<td>dry season</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>50</td>
<td>wet season</td>
<td>7</td>
<td>309</td>
<td>82.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sheep</td>
<td>50</td>
<td>dry season</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>50</td>
<td>wet season</td>
<td>6</td>
<td>334</td>
<td>65.3%</td>
</tr>
</tbody>
</table>

nd=not done

cies were Strongyles and Strongyloides. There was a negative correlation between egg counts and packed cell volume (PCV) in both sheep and goats.

**Tick counts**

Table 3 shows the results of tick counts and analysis of blood samples for heartwater antibodies. During the wet season the total tick counts in goats in Emorijoi, Ngoswani and Enkoje villages ranged from 0-625, 0-71 and 0-120 respectively, while in sheep, the counts ranged from 0-854, 0-309 and 0-600 in the three respective villages (Table 3). The most common tick species observed were Boophilus deoloratus, Rhipicephalus appendiculatus, R. evertis, Hyalomma marginatum and Amblyomma variegatum. No haemoparasites were observed during the survey in the two species of small ruminants.

**Prevalence of Heartwater**

The prevalence of antibodies to *Erhlichia ruminantium* in goats was significantly higher P<0.05) in Emorijoi than the other two villages Ngoswani and Enkoje as shown in (Table 3). This was consistent with the higher counts of the vector tick *Amblyomma variegatum* in Emorijoi.

The prevalence of antibodies to *E ruminantium* in sheep was significantly higher P<0.05 in Ngoswani (82.5% 33) than Emorijoi and Enkoje villages as shown in Table 3. However, this was not consistent with the total tick numbers recorded in the villages.
Discussion

In this study indigenous sheep and goats sampled in Narok District were found to be infected with trypanosomes as well as helminths. A similar observation was made in Kajiado District\textsuperscript{1}. Heartwater was also found prevalent in the study villages where livestock are kept under pastoral production system. Trypanosome infections were only recorded in Enkoje village. In this village the overall prevalence of trypanosomes recorded in goats was 4.6\% and 1.3\% in sheep and decreased significantly to 0\% in goats and increased to 2\% in sheep during the dry season but this increase in trypanosome prevalence was not significant. The observed decrease in trypanosome prevalence in goats could be attributed to the low tsetse challenge (range, 0-31, IFTD) recorded during the dry season. Two trypanosome species, \textit{T. congolense} and \textit{T. vivax} were identified in the two animal species with the latter being more common in goats than sheep. This is the first report of trypanosome infections in small ruminants in the study area. Previous studies in Narok District have mainly focused on cattle where trypanosomosis prevalence rate was reported as 5-6\%\textsuperscript{15}. The findings of this study do indicate that even in areas where tsetse challenge is low, trypanosome infections can be detected in small ruminants which may act as reservoirs for trypanosomes in cattle if left untreated. Previous studies on trypanosomosis and productivity constraints in small ruminants had similar findings\textsuperscript{1,16}. However, trypanosome infections had no significant effect on PCV in sheep and goats, as occurs in cattle. This is because there were only a few animals infected and the level of parasitaemia was very low. The differences observed in trypanosome infections between the three villages, which are approximately 10-20km apart, may be attributed to differences in the tsetse challenge or management practices. The low trypanosome infections observed in the study area may be managed by proper diagnosis followed by treatment of individual animals. In this study the proportion of young animals sampled was very small (135 adults and 8 lambs) compared to the adult so a comparison of parasitic infections between the age groups was not possible.

The gastrointestinal helminths observed in both species were mainly strongyle or strongyloides. Animals with high helminth egg counts were found to have low PCVs, which is measure of anaemia indicating a negative effect on the health of the animals. However the helminth infections decreased significantly during the dry season. Coccidia oocysts were also observed in a number of young animals and this could be the cause of some of the cases of diarrhoea reported by farmers.

This survey also revealed that heartwater is prevalent in small ruminants in Emorijoi, Ngoswani and Enkoje villages of Narok District. The prevalence of heartwater was significantly higher in sheep than in goats in the three villages sampled and same applied to the tick numbers. This could be attributed to differences in the grazing habits of the two animal species where goats are mainly browsers while sheep are grazers and the presence of wool in sheep to which ticks can easily attach compared to goats. Previous studies carried out on small ruminant production constraints\textsuperscript{1} based heartwater diagnosis on clinical signs and referred to his findings as unconfirmed. However in this study an antibody ELISA (map 1B) which is a highly specific test for \textit{Ehrlichia ruminantium} was used to test for infection...
thus rendering the findings as unconfirmation of the disease in the study area.

In conclusion this study recommends management of trypanosomosis in small ruminants by proper diagnosis and treatment. For effective management of heartwater a good tick control program for spraying the animals at least once every two weeks should be observed to control the vector tick *A. variegatum*. Peak worm infections occur 4-6 weeks in into the rains for effective management of helminthosis animals should be dewormed about 3-4 weeks into the rains when the worm challenge is high. A longitudinal study in the area is also recommended to establish the effect of trypanosomes, Cowdria and helminth infections on small ruminant productivity.

Acknowledgement

We wish to thank the Government of Kenya for funding this study, the Center Director KARI-TRC and the management for facilitation. Dr. R.E. Mdachi and Mr. G.N. Ngae for statistical analysis. The authors highly appreciated the technical assistance given by the epidemiology and residue analysis technical staff assistance given by the epidemiology and residue analysis technical staff. KARI/NVRC, Muguga staff for sample analysis and their good co-operation and all the farmers who allowed us to use their animals. This paper is published with the kind permission of the Director, KARI.

References

OCCURRENCE OF PARASITIC HELMINTHS AMONG SMALL RUMINANTS REARED UNDER TRADITIONAL HUSBANDRY SYSTEM IN OWERRI, SOUTH EAST NIGERIA

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PRÉSENCE DES HELMINTHES CHEZ LES PETITS RUMINANTS EN ELEVAGE TRADITIONNEL A OWERRI DANS LE SUD-EST DU NIGERIA

Résumé

On a mené une étude sur les parasites chez les races caprines et ovines naines de l'Afrique de l'ouest (WAD) dans trois localités de la région d'Owerri au sud-est du Nigeria. L'étude consistait en des examens des matières fécales pendant 18 mois pour détecter les œufs d'helminthes. Sur les 2 550 petits ruminants examinés, 71,4% et 28,6% étaient des chèvres et des moutons qui avaient des taux d'infection par les helminthes de 90,1% et 97,3% respectivement. L'infection par les nématodes était constamment élevée chez les deux espèces d'hôtes avec un taux moyen d'infection de 78,4%, tandis que l'infection par les trématodes et les cestodes était de 13% et 8,7% respectivement. On a enregistré des taux très élevés d'incidence des strongyles chez les deux espèces, soit 62,2% chez les chèvres et 41,3% chez les moutons. On a aussi noté un taux élevé d'incidence de *Skrjabinema ovis* (21,7%) chez les moutons. Il s'agit du premier rapport sur *Skrjabinema ovis* dans le sud-est du Nigeria. L'infection par les trématodes a révélé un taux très élevé de prévalence : *Paramphistomum sp.* (86,7%) chez les chèvres, *Cotylophoron cotylophorum* (40%) chez les moutons. S'agissant des cestodes, on a relevé un taux très élevé d'incidence de *Moniezia expansa* (50%) chez les chèvres, et *Avitellina centripunctata* (50%) et *Moniezia expansa* (50%) chez les moutons. Dans les localités faisant l'objet d'études, Ngor/Okpala avaient le taux le plus élevé d'infection par les nématodes : 37,8% et 37% pour les chèvres et les moutons, tandis qu'on a enregistré le taux le plus élevé de prévalence d'infection par les trématodes chez les chèvres à Owerri ouest (46,7%). La localité d'Owerri nord avait le taux de prévalence le plus élevé d'infection par les trématodes chez les moutons (46,7%).

Mots-clés: Présence, helminthes, petits ruminants, Owerri, Nigeria.

Summary

A study of helminth parasites in West African Dwarf (WAD) breeds of goats and sheep involving an 18 months faecal examinations for helminth eggs was carried out in three Local Government Areas (LGAs) of Owerri Zone Southeastern Nigeria. Of the 2,550 small ruminants examined, 71.4% and 28.6% were goats and sheep which had helminth infection rates of 90.1% and 97.3% respectively. Nematode infection was consistently high in the two species of hosts and gave a mean infection rate of 78.4%, while trematodes and cestodes recorded 13% and 8.7% respectively. Strongyles recorded the highest incidence rates in both species of animals, thus posting 62.2% in goats and 41.3% in sheep. *Skrjabinema ovis* equally recorded a high incidence rate in sheep which was 21.7%. This is the first report of *Skrjabinema ovis* in Southeastern Nigeria. Trematode infection showed a very high prevalence rate with *Paramphistomum sp.* recording 86.7% in goats, while *Cotylophoron cotylophorum* had a prevalence rate of 40% in sheep. Among the cestodes encountered, *Moniezia expansa* recorded the highest incidence rate of 50% in goats, whereas in the sheep *Avitellina centripunctata* and *Moniezia expansa* each equally posted 50%. Across the LGAs studied, Ngor/Okpala LGA had the highest nematode infection rate of 37.8% and 37% for both goats and sheep, while Owerri West (46.7%), recorded the highest prevalence rate for trematode infection in goats. Owerri North LGAs had the highest prevalence rate of 46.7% trematode infection in sheep.

Key-words: Occurrence, Helminths, Small ruminants, Owerri, Nigeria.

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Introduction

In Nigeria, small ruminants (sheep and goats) production is popular and a great number of them are sold annually\(^1\). Apart from producing hides, skins and other products, meat production is the most important. In the temperate regions of the world however, small ruminants are reared for both wool and meat\(^2\).

Although small ruminants are not as efficient as some other domestic animals in terms of production\(^3\), they can be self sufficient, maintained exclusively on open range and thus require low capital investment for shelter, management and feed. In the forest areas, south of latitude 14\(^{0}\)N, they are found roaming around the neighbourhood in villages and towns where they tend to be scavengers, feeding freely on roughages, forages and or plants found in open places\(^3\). As a result of this, they pick up myriad of invisible transmissible agents of infection such as parasites into their system, which affect their performance and production. Meat production (among other products) is a vital determinant in rating the efficiency of an animals’ productivity\(^4\).

Parasitic helminth infections constitute both economic and public constraints to profitable small ruminant production in most tropical environments such as Nigeria\(^5,6,7\). In these areas, they have been implicated as causes of general morbidity, young animal mortality, abattoir losses and increased cost of production through increased medication among others in virtually all the ruminant production systems\(^7,8\).

Over 800 species of round, flat and tapeworms have been reported to occur in Nigeria\(^9,10\). There is therefore always the need to not only identify the specific species encountered in our area, but also to understand the current status of helminth infections among small ruminants in our environments. Available published reports on the status of parasitic helminth infections of small ruminants in southeastern Nigeria are limited to the Nsukka area in Enugu State situated at the fringes of the Guinea Savanna zone of the region\(^11,12,13\). Such studies among small ruminants for Owerri which is in the rain forest zone of Southeastern Nigeria are however scanty and unpublished.

Faecal sampling for helminth eggs has been employed in most previous studies of helminth parasites in the tropics and has been shown to yield reliable results\(^14,15,16\). This paper reports on the occurrence of helminth parasites of small ruminants grazing the humid tropical rain forest area of Owerri, Southeastern Nigeria.

Materials and Methods

This study was carried out in three local government Areas (LAGs) of Owerri zone Southeast Nigeria. Owerri zone is located between latitudes 5\(^{0}\) and 6\(^{0}\)3’N and longitudes 6\(^{0}\)15’ and 7\(^{0}\)34’E in the southern rain forest vegetational belt of Nigeria. It is a major agricultural zone of Southeastern Nigeria. It has a tropical environment with two distinct seasons, the wet season, which extends from April to September and the dry season that runs through the remaining part of the year. This area had earlier been described\(^8\).

Sample collection and analysis

A total of 2,550 adult West African dwarf (WAD) small rumimants comprising of 1,820 goats and 730 sheep were examined for helminth parasites in Owerri West, Owerri North and Ngor/Okpala Local

The animals were routinely restrained and fresh faecal samples collected with a spatula from the rectum of each animal and taken to the laboratory within 3 hours for microscopic examination and identification of helminth eggs. The sex of each animal examined was also noted. The results were analyzed using descriptive statistics such as simple averages and percentages.

**Results**

Out of 2,550 small ruminants examined, 1,820 (71.4%) of them were goats while 730 (28.6%) were sheep. Among the goats, 1,640 (90.1%) were infected with mixed types of helminth parasites and 710 (97.3%) sheep were also infected. Overall, 2,350 (92.2%) of the small ruminants were infected.

The overall occurrence of nematodes, trematodes and cestodes in the different animal hosts is shown on Table 1. One thousand, six hundred and forty (1,640) and 670 cases of the different helminthes were encountered in goats and sheep respectively. Nematode infection was the most common helminth parasite, accounting for 1,640 (78.4%) of the cases followed by 300 (13.0%) and 200 (8.7%) recorded against trematodes and cestodes respectively.

The results of the occurrence of nematodes, trematodes and cestodes among goats in the three local government areas of Owerri zone are shown in Table 2. The highest occurrence of nematodes was recorded in Ngor/Okpala LGA, followed by Owerri North and Owerri West LGAs.

Among these nematodes strongyles were encountered most, thus recording 840 (62.2%) across the three LGAs, while *Strongyloides papillosus* which recorded 30 (2.2%) was the least nematode that occurred in these areas. The occurrence of trematodes was highest among small ruminants in Owerri West, followed by the incidence in Ngor/Okpala and Owerri North LGAs respectively. Majority of the trematodes encountered were of the genus *Paramphistomum*. Three genera of Cestodes (*Stilesia, Avitellina and Moniezia*) were encountered in the small ruminants examined in the three local government areas. Among these, *Moniezia expansa* was encountered most followed by *Stilesia globipunctata* and *Avitellina centripunctata* respectively across the LGAs.

Table 3 reports the prevalence of nematodes, trematodes and cestodes.

---

**Table 1** Overall occurrence of nematodes, trematodes and cestodes among small ruminants in Owerri, Southeastern Nigeria.

<table>
<thead>
<tr>
<th>Species of Animal</th>
<th>No. of cases encountered</th>
<th>Incidence (%) Nematodes</th>
<th>Incidence (%) Trematodes</th>
<th>Incidence (%) Cestodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goats</td>
<td>1640</td>
<td>1350 (82.3)</td>
<td>150 (9.1)</td>
<td>140 (8.5)</td>
</tr>
<tr>
<td>Sheep</td>
<td>670</td>
<td>460 (68.7)</td>
<td>150 (22.4)</td>
<td>60 (9.0)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2310</strong></td>
<td><strong>1810 (78.4)</strong></td>
<td><strong>300 (13.0)</strong></td>
<td><strong>200 (8.7)</strong></td>
</tr>
</tbody>
</table>
Table 2: Occurrence of nematodes, trematodes and cestodes among goats in the three LGAs of Owerri, Southeastern Nigeria.

<table>
<thead>
<tr>
<th>Type of Helminth</th>
<th>Sample Sites</th>
<th>Overall prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OW</td>
<td>ON</td>
</tr>
<tr>
<td>(A) NEMATODES</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Skrjabinema ovis</em></td>
<td>20 (5.6)</td>
<td>50 (10.4)</td>
</tr>
<tr>
<td>Strongyles</td>
<td>240 (66.7)</td>
<td>260 (54.2)</td>
</tr>
<tr>
<td><em>Gongylonema pulchrum</em></td>
<td>40 (11.1)</td>
<td>60 (12.5)</td>
</tr>
<tr>
<td><em>Nematodirus sp</em></td>
<td>20 (5.6)</td>
<td>20 (4.2)</td>
</tr>
<tr>
<td><em>Trichuris sp</em></td>
<td>40 (11.1)</td>
<td>60 (12.5)</td>
</tr>
<tr>
<td><em>Strongylonds papillosus</em></td>
<td>-</td>
<td>30 (6.3)</td>
</tr>
<tr>
<td><strong>Sub total</strong></td>
<td>360 (26.7)</td>
<td>480 (35.6)</td>
</tr>
</tbody>
</table>

|(B) TREMATODES            |              |                    |          |                  |
| *Paramphistomum sp.*     | 60 (85.7)    | 30 (100)           | 40 (80.0)| 130 (86.7)       |
| *Cotylophoron cotylophorum* | 10 (14.3)  | -                  | -        | 10 (6.7)         |
| *Schistosoma bovis*      | -            | -                  | 10 (20.0)| 10 (6.7)         |
| **Sub total**            | 70 (46.7)    | 30 (20.0)          | 50 (33.3)| 150 (9.1)        |

|(C) CESTODES              |              |                    |          |                  |
| *Stilesia globipunctata* | 40 (80.0)    | -                  | -        | 40 (28.6)        |
| *Avitellina centripunctata* | 10 (20.0)  | 20 (33.3)          | -        | 30 (21.4)        |
| *Moniezia expansa*       | -            | 40 (66.7)          | 30 (100) | 70 (50.0)        |
| **Sub total**            | 50 (35.7)    | 60 (42.9)          | 30 (21.4)| 140 (8.5)        |

*OW = Owerri West, ON = Owerri North & NO = Ngor/Okpala.*

Among sheep in the three LGAs of Owerri Zone, Southeastern Nigeria. Again, the most common helminth parasites encountered among the sheep examined were nematodes, followed by trematodes and then cestodes.

The highest prevalence of the nematodes was recorded among sheep in Ngor/Okpala, and Owerri West LGAs, each recording 170 (37%), while the prevalence rate in Owerri North is 120 (26.1%). Strongyles again recorded the highest prevalence rate of 190 (41.3%), followed by *Skrjabinema ovis* which recorded 100 (21.7%). Again, *Strongylodes papillosus* had the least prevalence rate of (10) 2.2%. Among the trematodes encountered in the sheep, *Cotylophoron cotylophorum* had a higher prevalence rate than *Paramphistomum sp.* Equally among the sheep examined in the three LGAs, *Avitellina centripunctata* and *M. expansa* were the two
Table 3: Occurrence of nematodes, trematodes and cestodes among sheep in the three LGAs of Owerri, Southeastern Nigeria.

<table>
<thead>
<tr>
<th>Type of Helminth</th>
<th>Sample Sites</th>
<th>Overall prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OW</td>
<td>ON</td>
</tr>
<tr>
<td>(A) NEMATODES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skrjabinema ovis</td>
<td>40 (23.5)</td>
<td>30 (25.0)</td>
</tr>
<tr>
<td>Strongyles</td>
<td>60 (35.3)</td>
<td>50 (41.7)</td>
</tr>
<tr>
<td>Gongylonema pulchrum</td>
<td>30 (17.6)</td>
<td>10 (8.3)</td>
</tr>
<tr>
<td>Nematodirus sp.</td>
<td>20 (11.8)</td>
<td>-</td>
</tr>
<tr>
<td>Trichuris sp</td>
<td>20 (11.8)</td>
<td>20 (16.7)</td>
</tr>
<tr>
<td>Strongyloides papillosus</td>
<td>-</td>
<td>10 (8.3)</td>
</tr>
<tr>
<td>Sub total</td>
<td>170 (37.0)</td>
<td>120 (26.1)</td>
</tr>
<tr>
<td>(B) TREMATODES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paramphistomum sp.</td>
<td>30 (75.0)</td>
<td>10 (14.3)</td>
</tr>
<tr>
<td>Cotylophoron cotylophorum</td>
<td>10 (25.0)</td>
<td>30 (42.9)</td>
</tr>
<tr>
<td>Schistosoma bovis</td>
<td>-</td>
<td>30 (42.9)</td>
</tr>
<tr>
<td>Sub total</td>
<td>40 (26.7)</td>
<td>70 (46.7)</td>
</tr>
<tr>
<td>(C) CESTODES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stilesia globipunctata</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Avitellina centripunctata</td>
<td>-</td>
<td>20 (66.7)</td>
</tr>
<tr>
<td>Moniezia expansa</td>
<td>-</td>
<td>10 (33.3)</td>
</tr>
<tr>
<td>Sub total</td>
<td>-</td>
<td>30 (50.0)</td>
</tr>
</tbody>
</table>

*OW = Owerri West, ON = Owerri North & NO = Ngor/Okpala.

cestodes encountered, while S. globipunctata was not recorded.

The influence of sex on the prevalence of small ruminant helminth infections is presented on Table 4. Nematode infection was higher among female goats and sheep than in the males. Across parasite species, prevalence rates, were higher among all the parasites in females than male goats. All the nematodes encountered had higher prevalence rates in female sheep than in the males.

Similarly, the overall prevalence of trematodes was higher in female goats than in the males. The prevalence of Paramphistomum sp was higher in females than in the male goats, while the single prevalence of C. cotylophorum was encountered among the male goats.

In the sheep, the two species of trematodes recovered had higher prevalence rates in the females than in the males. The prevalence of small ruminant cestodes was higher in the female goats than in the males, while the prevalence rates were equal in both sexes for sheep. Across cestode species, prevalence rates were higher for S. globipunctata and M. expansa in female
Table 4: Influence of sex on the incidence of nematodes, trematodes and cestodes among small ruminants in Owerri, Southeastern Nigeria.

<table>
<thead>
<tr>
<th>Type of Helminth</th>
<th>Incidence</th>
<th>Male (520)</th>
<th>Female (1300)</th>
<th>Incidence</th>
<th>Male (210)</th>
<th>Female (520)</th>
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<td>(A) NEMATODES</td>
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<tr>
<td>Skrjabinema ovis</td>
<td>120</td>
<td>30 (25.0)</td>
<td>90 (75.0)</td>
<td>100</td>
<td>40 (40.0)</td>
<td>60 (60.0)</td>
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<tr>
<td>Strongyles</td>
<td>860</td>
<td>230 (26.7)</td>
<td>630 (73.3)</td>
<td>240</td>
<td>60 (25.0)</td>
<td>180 (75.0)</td>
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<td>Gongylonema pulchrum</td>
<td>150</td>
<td>30 (20.0)</td>
<td>120 (80.0)</td>
<td>30</td>
<td>10 (33.3)</td>
<td>20 (66.7)</td>
</tr>
<tr>
<td>Nematodirus sp.</td>
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<td>10 (25.0)</td>
<td>30 (75.0)</td>
<td>60</td>
<td>20 (33.3)</td>
<td>40 (66.7)</td>
</tr>
<tr>
<td>Trichuris ovis</td>
<td>150</td>
<td>30 (20.0)</td>
<td>120 (80.0)</td>
<td>40</td>
<td>10 (25.0)</td>
<td>30 (75.0)</td>
</tr>
<tr>
<td>Strongyloides papillosus</td>
<td>30</td>
<td>10 (33.3)</td>
<td>20 (66.7)</td>
<td>10</td>
<td>-</td>
<td>10 (100.0)</td>
</tr>
<tr>
<td><strong>Sub total</strong></td>
<td>1350</td>
<td>340 (25.2)</td>
<td>1010 (74.8)</td>
<td>480</td>
<td>140 (29.2)</td>
<td>340 (70.8)</td>
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<td>(B) TREVATODES</td>
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<td>Paramphistomum sp.</td>
<td>130</td>
<td>10 (7.7)</td>
<td>120 (92.3)</td>
<td>50</td>
<td>-</td>
<td>50 (100.0)</td>
</tr>
<tr>
<td>Cotylophoron cotylophorum</td>
<td>10</td>
<td>10 (100.0)</td>
<td>-</td>
<td>60</td>
<td>20 (33.3)</td>
<td>40 (66.7)</td>
</tr>
<tr>
<td>Schistosoma bovis</td>
<td>10</td>
<td>-</td>
<td>10 (100.0)</td>
<td>40</td>
<td>-</td>
<td>40 (100.0)</td>
</tr>
<tr>
<td><strong>Sub total</strong></td>
<td>150</td>
<td>20 (13.3)</td>
<td>130 (86.7)</td>
<td>150</td>
<td>20 (13.3)</td>
<td>130 (86.7)</td>
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<td>(C) CESTODES</td>
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<td></td>
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</tr>
<tr>
<td>Stilesia globipunctata</td>
<td>40</td>
<td>10 (25.0)</td>
<td>30 (75.0)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Avitellina centripunctata</td>
<td>30</td>
<td>20 (66.7)</td>
<td>10 (33.3)</td>
<td>30</td>
<td>10 (33.3)</td>
<td>20 (66.7)</td>
</tr>
<tr>
<td>Moniezia expansa</td>
<td>70</td>
<td>20 (28.6)</td>
<td>50 (71.4)</td>
<td>30</td>
<td>20 (66.7)</td>
<td>10 (33.3)</td>
</tr>
<tr>
<td><strong>Sub total</strong></td>
<td>140</td>
<td>50 (35.7)</td>
<td>90 (64.3)</td>
<td>60</td>
<td>30 (50.0)</td>
<td>30 (50.0)</td>
</tr>
</tbody>
</table>

Goats while A. centripunctata had a higher prevalence rate among the males than female goats. While A. centripunctata was recorded more among the female sheep than males, the reverse was the case with M. expansa. S. globipunctata was not recorded among the sheep examined.

**Discussion**

The results of the present study show that nematodes are the most common helminth parasites in small ruminants grazing the study areas. This agrees with the findings in northern parts of the country for the same hosts\(^5\). Similar predominance of nematode eggs in faecal samples from sheep in Kenya has also been reported\(^6\). Mixed parasitism involving two or more helminth genera was common in the present study and is in agreement with earlier reports\(^1\) in small ruminants\(^13\) and in domestic fowls\(^20\).

Generally, the prevalence of helminth parasitism was high in the two species of
small ruminants (90.1% and 97.3%). Again, this agrees with the 93.4% earlier reported for eastern Nigeria\textsuperscript{12}, probably indicating lack of improvement in our animal health management programmes, or non-adoption of the modern animal health care programmes among the traditional smallholder livestock producers that still predominate the zone.

In goats, high prevalence rates of nematode eggs were obtained for Strongyles, \textit{G. pulchrum}, \textit{Trichuris sp} and \textit{S. ovis}; trematodes, \textit{Paramphistomum sp} and cestodes, \textit{S. globipunctata}, \textit{M. expansa} and \textit{Avitellina centripunctata}. Similar trends were observed among the parasites of sheep which also included the nematode, \textit{Nematodirus sp}; trematode, \textit{C. cotylophorum} and \textit{S. bovis}. This is the first time that the nematode \textit{S. ovis} will be reported among small ruminants in southeastern Nigeria. The array of helminth parasites in goats and sheep are similar to the ones documented as the principal causal agents of parasitic gastroenteritis (PGE) in ruminants\textsuperscript{21, 22, 23}. Equally, it has been reported that Strongyles were among the most commonly encountered helminthes in PGE cases of small ruminants in Kenya and northern Nigeria respectively.

The presence of 3 species of trematodes and 3 cestodes in goats; 3 trematodes and 2 cestodes in sheep in the present study is in line with earlier observations that cestodes are also contributing to the serious morbidity associated with gastroenteritis in ruminants\textsuperscript{5, 6, 19}.

Most of the animals examined appeared to be in fairly good health condition, but yielded different types of helminth eggs during examinations. A good number of rural livestock owners in the study areas saw helminth infection as a predetermined coincidental manifestation, which nobody could do anything to prevent. Female small ruminants were more infected with helminth parasites than their male counterparts. This may be due to the physiological peculiarities of the female animals, which usually constitute stress factors thus, reducing their immunity to infections\textsuperscript{24}.

**Conclusion**

Helminth parasites devastate ruminants in the tropics and continually drain the economic gains from these animals. The present prevalence rates especially Strongyles, \textit{Paramphistomum} and \textit{Moniezia} in goats; Strongyles, \textit{Cotylophorum}, \textit{Moniezia} and \textit{Avitellina} in sheep are still relatively too high for efficient livestock production in the study areas. Thus, concerted efforts should therefore be made to educate the rural small ruminant producers to embrace modern livestock disease control programmes and specifically the need for routine deworming of their stock.

**References**

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ASSESSMENT OF DRUG USAGE AND ANTIMICROBIAL RESIDUES IN MILK ON SMALLHOLDER FARMS IN MOROGORO, TANZANIA.

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EVALUATION DE L'UTILISATION DES MEDICAMENTS ET DETERMINATION DES RESIDUS ANTIMICROBIENS DANS LE LAIT DANS LES PETITES EXPLOITATIONS AGRICOLES A MOROGORO EN TANZANIE

Résumé

On a eu recours à une enquête par questionnaire et à une inspection au niveau des fermes, en vue de déterminer les types de médicaments utilisés pour traiter les maladies animales, recueillir des informations sur l'incidence de la mammite clinique et sur les pratiques qui consistent à jeter le lait, dans 59 petites fermes laitières choisies au hasard dans la municipalité de Morogoro en Tanzanie. Des échantillons de lait étaient également collectés, afin d'évaluer les résidus de médicaments antimicrobiens à l'aide de trois tests : le Delvotest® SP, le Test de diffusion en gélose et le Test sur plaque à l'agar. Le jour de la visite de la ferme, 25,4% des fermes faisaient l'objet d'études avaient recours à divers médicaments pour traiter les animaux. Les médicaments étaient classés comme suit : antimicrobiens (54,2%), anthelmintiques (25%), antiprotozoaires (8,3%), pesticides (8,3%) et anti-anémiques (4,2%). Par ailleurs, 25 paysans ont déclaré avoir observé la mammite clinique chez les vaches et 84% d'entre eux avaient recours aux infusions intramammaries pour traiter les quartiers infectés. Lors de la validation, tous les tests détectaient la dihydrostreptomycine, l'oxytetracycline et la gentamycine en-dessous de la limite maximum de résidu recommandée par le Codex Alimentarius, mais des disparités ont été notées quant à la détection de résidus de pénicilline. Le Delvotest® SP s'est avéré plus fiable que les deux autres tests. Seul 1/59 échantillons de lait (1,7%) examinés avait des résidus antimicrobiens, tel que détecté par le Delvotest® SP, ce qui montre que les résidus antimicrobiens dans le lait dans les petites fermes laitières dans la municipalité de Morogoro ne constituaient pas un sérieux problème.

Mots-clés: Médicaments, résidus, petites exploitations agricoles, Morogoro, Tanzanie.

Summary

Questionnaire survey and on-farm inspection were used to establish types of drugs used to treat livestock diseases, to collect information on occurrence of clinical mastitis and milk discarding practices on 59 randomly selected smallholder dairy farms in Morogoro municipality, Tanzania. Milk samples were also collected for evaluation of antimicrobial drug residues using three tests: the Delvotest®SP, agar well diffusion and agar plate disc assays. On the day of farm visit, 25.4% of study farms had various drugs used to treat animals, categorised as antimicrobials (54.2%), anthelmintics (25.0%), anti-protozoans (8.3%), pesticides (8.3%) and anti-anemias (4.2%). In addition, 25 farmers reported to have observed clinical mastitis in cows and 84% of them used intramammary infusions to treat infected quarters. During the validation, all the tests detected dihydrostreptomycin, oxytetracycline and gentamicin below the Codex Alimentarius recommended Maximum Residue Limit (MRL) but disparities were observed with reference to detection of penicillin residues. The Delvotest®SP was found to be more reliable than the other two tests. Only 1 (1.7%) of 59 milk samples screened had antimicrobial residues as detected by the Delvotest®SP suggesting that antimicrobial residues in milk in the smallholder farms in Morogoro municipality may not be a serious problem.

Key words: Drugs, residues, smallholder farms, Morogoro, Tanzania.

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Introduction

Application of drugs by various practitioners for treatment (chemotherapy) or prevention (chemoprophylaxis) of diseases, if not properly done, may lead to harmful effects including poisoning or presence of residues in foods of animal origin such as milk. Presence of drug residues in milk poses public health problems as well as economic problems to milk processors. Undesirable health risks that may be associated with drug residues in milk include allergic reactions in humans and development of resistant strains of pathogens which are consequently difficult to eliminate in the human population. For instance, about 5-10% of the human population is hypersensitive to penicillin or other antimicrobials and suffers allergic reactions at concentration as low as 1 part per billion (ppb) of penicillin1. Human health problems resulting from prolonged intake of tetracycline in food, including milk, may lead to gastro-intestinal disturbance, poor foetal development and hypersensitivity2,3. Other effects of antimicrobials in milk include interference with the processing of dairy products such as yoghurt, cheese and butter leading to sub-standard products4.

In the developed countries, milk is routinely checked for drug residues and milk supplies containing detectable concentrations of antimicrobials are not acceptable for human consumption1. In the developing countries, milk is not routinely checked for presence of antimicrobial residues, thereby posing health risks to consumers. In the latter, the private sector is at its infancy after most governments withdrew from provision of public animal health services. This has resulted in animal health services being sub-optimal and, increased tendency for animal owners to stock drugs in their houses and engagement of unskilled manpower such as farmers themselves and animal attendants to treat the animals. Thus, indiscriminate use of drugs is possible and may be contributing to the presence of drug residues in milk. Also, ability and tendency of farmers to observe drug withdrawal periods following treatment may have a considerable value in reducing chances for the presence of drug residues in milk. Therefore, the objectives of this study were to establish types of veterinary drugs available on the smallholder dairy farms; evaluate observation of drug withdrawal requirements following treatment and to estimate magnitude of antimicrobial residues in milk so as to shed light on health risks associated with milk consumption from the smallholder dairy sector in Tanzania.

Materials and methods

Study design and selection of study farms

The cross-sectional study was carried out on smallholder dairy farms within Morogoro municipality, Tanzania, during September 2004 in order to establish an inventory of drugs used and stocked by farmers; how farmers handle milk from treated animals and to evaluate the presence of antimicrobial residues in milk at the farm-level. The study was carried out on 59 smallholder dairy farms selected by simple randomisation from a sampling frame of all smallholder farms (n=148) in different wards of Morogoro municipality. The study farms included those from Boma (17%), Kichangani (17%), Kilakala (12%), Mazimbu (42%), Mbuyuni (7%) and Milimani (5%) wards.

Data collection

Questionnaire survey and on-farm inspections were used to record veterinary drugs and acaricides available on the day of farm visit. Information on who attends sick animals and number of lactating cows, which were sick and treated one week before farm
visit was also collected. In addition, information related to occurrence and management of clinical mastitis cases, including practices of discarding milk from a lactating cow infused or injected with antibiotics was collected. Awareness on compliance with milk withdrawal period after treatment was also assessed. Finally, milk sample from a common collecting container for milk sold at each study farm was collected and submitted for laboratory analysis in order to establish the presence of antimicrobial residues in milk.

Evaluation for presence of antimicrobial residues in milk

Three tests namely the Delvotest®SP (DSM, Netherlands) that uses *Bacillus stearothermophilus* var. *calidolactis* as the test organism with an indicator dye in the media and, agar well diffusion and agar plate disc assays (which use *Bacillus subtilis* as a test organism) were used to detect presence of antimicrobial residues in milk from the 59 study farms. Before using them to screen test milk samples, the tests were validated using milk samples collected from a cow belonging to the Faculty of Veterinary Medicine (FVM), Sokoine University of Agriculture that had not been under treatment for the past two months. Briefly, four drugs commonly used to treat cattle in Morogoro were purchased from a veterinary input supply shop and used for validation experiment. The drugs used were oxytetracycline (Oxytetracycline® 10%, Alfasan, Woerden, Holland), gentamicin (GENTA® 10%, Phenix Pharmaceuticals and Kela Laboratory, Hoogstraten, Belgium) and penicillin-dihydrostreptomycin preparation (Pen&Strep®, Norbrook, Newry, Northern Ireland). Each drug was used to fortify milk collected from the cow at the FVM and serially diluted 10-folds to provide 10 levels of dilution. This was done by taking one ml of each drug and adding to nine ml of milk, followed by thorough mixing and thereafter one ml was taken and transferred into the next tube also containing 9 ml of milk. The procedure was repeated to provide 10 serial dilutions ranging from 1:10^1 to 1:10^10.

Aliquots of various dilutions for each drug were then used in agar wells and agar plate discs and incubated at 37°C for 24 hours while for the Delvotest®SP test, samples were incubated at 64°C for three hours before reading the results. Positive results were based on presence of inhibition zone around the wells or discs for the agar well diffusion or agar plate disc assay respectively. For the Delvotest®SP, a positive result was based on failure of gel to change from purple to yellow colour after incubation as an indication of bacterial growth inhibition. The minimum inhibition concentration (MIC) was computed from the lowest concentration corresponding to the highest dilution of the milk samples that inhibited growth of *B. subtilis* or *B. stearothermophilus* var *calidolactis*. Three experiments were made for each test and the average MIC value was used as detection level of each test. In order to harmonise with Maximum Residue Limit (MRL) value defined in mg/L by the Codex Alimentarius or Health Canada, all values of MIC obtained were converted to mg/L units.

Results

Treatment of sick animals and possession and application of veterinary drugs and acaricides

Of the 59 farms visited, only 10% reported to have their lactating animals treated within one week before farm visit and the number of conditions reported on these farms included trypanosomosis, mastitis, pink eye, retained placenta, undefined fever and foot and mouth disease (FMD). In-
Table 1. Drugs and chemicals found on smallholder dairy farms in Morogoro municipality, Tanzania.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Category</th>
<th>No. of farms having it</th>
<th>Examples of trade names of products possessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diminazene diaceturate</td>
<td>Antiprotozoan</td>
<td>2</td>
<td>Veriben®, Dimisan®</td>
</tr>
<tr>
<td>Oxytetracycline</td>
<td>Antibiotic</td>
<td>10</td>
<td>OTC® 10%, OTC® 20%</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>Antibiotic</td>
<td>3</td>
<td>Genta-Kel®, GENTA® 10%</td>
</tr>
<tr>
<td>Levamisole</td>
<td>Anthelmintic</td>
<td>1</td>
<td>Tramazole®</td>
</tr>
<tr>
<td>a-Cypermethrin</td>
<td>Pesticide</td>
<td>1</td>
<td>Paranex®</td>
</tr>
<tr>
<td>Carbaryl</td>
<td>Pesticide</td>
<td>1</td>
<td>Sevin®</td>
</tr>
<tr>
<td>Iron dextran</td>
<td>Antianaemic</td>
<td>1</td>
<td>Ridon®</td>
</tr>
</tbody>
</table>

Injectable oxytetracycline (OTC 10%) was reported to be used for animals that had retained placenta, unidentified fever and FMD, while OTC powder was used to treat cows with pink eye. In case of mastitis, intramammary infusion (Terrexine®) was used, while trypanosomosis was treated with diminazene diaceturate (Veriben®). Extension officers attended the majority of sick animals (61%), veterinarians (18%) and farmers (4%). Sometimes, treatment of sick animals was reported to be carried out jointly between field officers and veterinarians or field officers and farmers (Figure 1).

It was also found that of the 59 farms visited, 25% had various veterinary drugs other than acaricides. Types of drugs that were in possession of farmers on the day of farm visit are shown in Table 1 and, were broadly classified as antibiotics (54.2%), anthelmintics (25.0%), anti-protozoans (8.3%), pesticides (8.3%) and anti-anaemics (4.2%). The products were used to treat different conditions of cattle; iron dextran was used to prevent anaemia in piglets.

On-farm inspection revealed that 90% of the farmers stocked acaricides that were used for general-purpose application including tick control on cattle and small animals, particularly dogs. The acaricides encountered on the day of farm visit comprised organophosphates (Steladone® 48.1%), synthetic pyrethroids (Dominex® 25.0%, Ecolfleece® 3.8% and Bayticol® 1.9%) and formamidines (Taktic® 15.5%, Tixfix® 3.8% and Almatix® 1.9%).

Disposal of milk from treated cows and observation of drug withdrawal requirements

Twenty-five farmers (42.4%) out of 59 visited reported to have observed clinical mastitis in cows and 84% of them used intramammary infusions to manage mastitis cases. Whereas all farmers reported to be discarding milk from mastitic cows infused with antibiotics, only 69.8% reported to discard milk from cows treated with injectables. However, even those reporting to be discarding milk from infused cows, only 33% were doing so for milk from all quarters and the rest (i.e. 67%) discarded milk from infused quarters only. It was further reported that whereas households with cows infused with intramammary tubes did not use milk for either home consumption or selling to others, those who treated animals with
systemic drugs, used the milk from treated animals for either home consumption (23%) or even selling it to others (14%). Duration of discarding milk was significantly higher for cows infused with intra-mammary tubes (5.0±2.0 days) than that for cows treated with injectables (3.9±1.7 days) (p<0.05).

Validation of microbial inhibitor tests

All the three tests detected oxytetracycline below the MRL defined by the Codex Alimentarius (100 μg/L). However, the Delvotest®SP detection ability was superior (0.1 μg/L) to that of agar well diffusion and agar plate disc assays, which was 40 μg/L.

For penicillin and dihydrostreptomycin, detection levels by the three tests are shown in Figures 2a and 2b. Only the Delvotest®SP was able to detect penicillin below the MRL of 4 μg/L, whereas the lowest average detection levels by the agar well diffusion (74 μg/L) and agar plate disc (134 μg/L) assays were higher than the MRL value. For the dihydrostreptomycin, all three tests were able to detect this drug below the MRL of 200 μg/L but again the Delvotest®SP...
was superior to the two agar-based tests.

For detection of gentamicin, MRLs of between 100 and 400 μg/L as defined by the Health Canada were used because currently the Codex Alimentarius has not established MRL value for this drug. Performance of the three tests with respect to detection of gentamicin in milk is shown in Figure 2c. The results show that although the tests were able to detect the drug below the lower limit of the MRL, again the Delvotest®SP showed superior performance than the other two tests.

**Presence of antibiotic residues in milk**

Only one (1.7%) of the 59 milk samples collected at farm level on smallholder dairy units in Morogoro was detected by the Delvotest®SP to be containing antibiotic residues. The other two tests could not detect antibiotic residues in the same milk samples.

**Discussion**

The results of this study indicate that the majority (61%) of clinical cases in the smallholder dairy farms in Morogoro municipality were attended by field officers, while veterinarians and farmers attended the rest. Offering of animal health services by paraprofessionals instead of veterinarians may be attributed to the withdrawal of government from animal health delivery services in the early 1990s with the tendency for the few veterinarians resorting to owning veterinary drug shops. A similar trend has been observed in most urban areas in Tanzania with the exception of Dar-es-Salaam where there is a large concentration of private veterinary practitioners. The situation in the rural areas of Tanzania is even worse as there are no private veterinary practitioners and as such, all the services are in the hands of paraprofessionals and/or the unskilled cadre of community-based animal health workers in areas where paraprofessionals are not available. The main reasons for reliance on paraprofessional animal health services are poor development and lack of veterinary services in some areas of the country particularly in remote areas, with harsh environments, difficult terrain and poor infrastructure. This type of animal health delivery structure is also operating in most countries in the Eastern and Southern African and other developing countries.

The results of this study have also shown that the main drugs possessed by farmers were antibiotics and anthelmintics. Of interest was the observation that the majority of the respondents reported to buy
them from the veterinary input supply shops available in Morogoro municipality, even without proper prescription. Therefore, drugs such as antibiotics can easily get into the hands of unqualified people thereby possibly leading to misuse of such drugs and potentially posing health risks to humans when drug withdrawal requirements are not observed. Indiscriminate use of veterinary products by unskilled people may pose disease pathogen or vector resistance problems as observed in relation to use of acaricides elsewhere\textsuperscript{11}. In addition, the stocking of these drugs in homes including storing drugs in refrigerators used for food storage also pose potential health risks to children who may have access to the drugs and even contaminating the food.

Although all farmers reported to be discarding milk from cows infused with antibiotics when attending clinical mastitis cases, it was found that majority (67\%) did so from treated quarters only. Milk from quarters not affected and treated is normally used for home consumption or sold to other consumers. Ideally, it is recommended to discard milk from all quarters irrespective of infusion status\textsuperscript{4}. The practice by farmers in Morogoro municipality, therefore, indicates that milk that is supposed to be discarded enters the human food chain, thereby posing immense health risks to milk consumers. Similarly, potential health risks may be associated with the tendency of farmers allowing milk from animals injected with antibiotics systemically to be used for home consumption or sale. Although, the practice of not discarding milk from non-infused quarters or systemically treated animals may be attributable to ignorance on the part of farmers in relation to health risks, it is also possible that this tendency is related to economic reasons because farmers would like to avoid loss of revenue that is associated with discarding milk from treated animals. Despite the fact that in this study only one milk sample out 59 had drug residues, there is still an urgent need to educate farmers on the potential health risks associated with consumption of milk that is supposed to be discarded and their obligation to protect the health of the consumers.

The results of the validation of tests provided important clues as to the choice of test to be adopted for use in routine monitoring of antimicrobial residues in milk. The trial showed that the Delvetest®SP, which is approved for on-farm testing of presence of antibiotic residues in milk\textsuperscript{12} in developed countries, was superior and reliable test as it detected presence of antimicrobial residues with reference to penicillin, dihydrostreptomycin, oxytetracycline and gentamicin below MRL. The superiority of the Delvetest®SP observed in this study may be explained by sensitivity of the test organism, \textit{Bacillus stearothermophilus} var \textit{calidolactis} as compared to \textit{B. subtilis} used for other two tests as also reported by others\textsuperscript{13}. Although the agar well diffusion test and agar plate disc assay detected oxytetracycline, gentamicin and dihydrostreptomycin below MRL, their failure to detect the presence of penicillin below MRL indicates that they cannot be relied upon for routine monitoring of antimicrobial residues in milk. This is because about 5-10\% of the human population is hypersensitive to penicillin or other antimicrobials and suffers allergic reactions at concentration as low as 1 ppb penicillin and hence necessitates the use of a reliable test in routine drug residue monitoring\textsuperscript{1}.

In conclusion, this study has indicated the scope of drug stocking by farmers and their practices in relation to milk discarding
following treatment of mastitis or systemic infections, which underline the need to carry out sensitisation of farmers in respect to safe keeping of drugs at homes as well as observing drug withdrawal requirements. In addition, the presence of antibiotic residues in only one sample suggests that antimicrobial residues may not be a serious problem. However, more work involving larger sample sizes and carried out in different seasons of the year is required to confirm the observed results.

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CONTAGIOUS BOVINE PLEUROPNEUMONIA (CBPP) POST-VACCINAL COMPLICATION IN ETHIOPIA

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COMPLICATION APRES LA VACCINATION CONTRE LA PERIPNEUMONIE CONTAGIEUSE BOVINE (PPCB) EN ETHIOPIE

Résumé

En Ethiopie, on a eu recours au cours des quatre dernières décennies à l'immunisation des bovins contre la péripneumonie contagieuse bovine (PPCB) en utilisant des vaccins préparés à partir d'une semence vaccinale résistante à la streptomycine. Tout récemment, une souche vaccinale dénommée T.44 a été introduite en Ethiopie pour préparer des vaccins destinés à être utilisés sur le terrain. Au total, 296.228 bovins étaient vaccinés avec des vaccins produits à partir de cette semence vaccinale dans trois différentes régions de l'Ethiopie. La réaction post-vaccinale affectait 1,02% des animaux vaccinés (95% IC : 1.0192 - 1.024), tandis que les taux de mortalité et de cas de fatalité étaient de 0,17% et 16,5% respectivement. Les cas de réaction étaient beaucoup plus fréquents dans l'ouest de Wellega (P<0,001) que dans les deux autres régions. Le point d'inoculation s'est avéré être le principal facteur prédisposant dans toutes les trois régions considérées. La réaction post-vaccinale a entraîné des pertes économiques considérables et affectait le moral de la communauté des éleveurs démunis. Il faudrait un respect strict de toutes les précautions et directives, afin de réduire les pertes éventuelles après les vaccinations en masse.

Mots-clés: PPCB, réaction post-vaccinale, Ethiopie.

Summary

In Ethiopia, immunization of cattle against Contagious Bovine Pleuropneumonia (CBPP) has been practised for the last 4 decades using vaccines prepared from streptomycin resistant vaccine seed strain. Recently, a vaccine strain denominated T.44 has been introduced to Ethiopia to prepare vaccines for field use. A total of 228 cattle were vaccinated with vaccines produced from this seed strain in three different zones of Ethiopia. Post - vaccinal reaction affected the vaccinated animals with over all attack rate of 1.02% (95% C.I.: 1.0192, 1.024) while the mortality and case - fatality rates were found to be 0.17% and 16.5% respectively. The occurrence of the reaction was found to be significantly higher in Western Wellega zone (P<0.001) than the other two zones. Site of inoculation was shown to be the main predisposing factor in all the three zones considered. The post-vaccinal reaction caused substantial economic loss and moral demotion to the resource poor livestock owning community. Strict adherence to all precautions and guide-lines needs to be adopted in order to reduce the likely loss following mass vaccinations.

Key-words: CBPP, post-vaccinal reaction, Ethiopia.
Introduction

Contagious Bovine Pleuropneumonia (CBPP) is a contagious respiratory disease of cattle caused Mycoplasma mycoides subspp. mycoides small colony (Mmm sc- bovine biotype) of the class mollicutes. Under natural conditions it affects only domestic ruminants of the genus Bos, i.e. mainly Bos taurus and Bos indicus. It is characterized by morbidity rate, that could be as high as 75-90%. The mortality rate seems to vary usually between 50 to 90% while the case fatality rate was found to be 50%. In general, CBPP mortality rates endemic areas it assumes the following pattern: 13% of the animals develop the hyperacute form, 20% the acute form, 46% the sub-acute form while approximately 21% of the animals are resistant. This situation has also been realized in epizootic cases.

CBPP is an endemic disease in most of Africa, Asia and few European countries. Even though sufficient information is lacking on the epizootiology of CBPP in Ethiopia, it was thought to be a problem of lowland pastoral areas with incursion into the adjacent highlands. However, the recent outbreaks in Addis Ababa and North Shewa, which belong to the Addis Ababa dairy shed obviates the risk it carries into the dairy sector in the near future. Thus the economic impact that CBPP poses on the agricultural sector and national economy of the country is subtle. For instance, Laval, 1999 reported that CBPP incurs a cost of over ETB $ 205.6 million per annum in Ethiopia.

CBPP had been eradicated from USA, Australia and most of Europe through implementation of policy of restriction of animal movement and stamping out. It remains endemic in Africa where effective vaccination policy seems the only realistic method of choice for control of CBPP.

In Ethiopia vaccination against CBPP has been carried out since 1964. Initially both culture based vaccine prepared from KH3-J vaccine strain of Mycoplasma mycoides subspecies mycoides small colony bovine Bio-type was used extensively during the years 1964-1968. In the later year (since 1969) a more stable freeze-dried vaccine prepared from the same strain was used. A need arose during the PARC (Pan African Rinderpest Campaign) program to combine CBPP and the rinderpest vaccines in an attempt to eradicate rinderpest and possibly control CBPP. Hence the streptomycin resistant variant of KH3-J, KH3j-SR came into use until 1988 when it was replaced by T1-SR, that is streptomycin resistant vaccine strain T1 of the causative mycoplasma. In 1996 a streptomycin sensitive but more immunogenic variants of the vaccine strain - T1 denominated T1/44 was recommended by FAO as the only vaccine strain of choice T1-SR was constrained by lower potency and efficacy. No CBPP vaccination campaign had been followed by post-vaccinal reaction in Ethiopia before introduction of T/44 as the seed strain. However, immunization of animals with vaccine prepared from T1/44 caused post-vaccinal complication in different regions. The objective of this paper was, therefore, to investigate the magnitude of the reaction and its impact on the livestock owners.

Materials and methods

Study Areas

The study was undertaken in three zones where vaccination with T1/44 has been carried out namely Borana, South Omo and Western Wellega. In Borana zone the vaccination was given in four districts. The
annual mean temperature varies from 19° C
to 25° C with moderate seasonal variation.
The mean annual rainfall ranges from
250mm to 700mm with bimodal distribution.
Pastoral livestock production is the main
means of livelihood for hundreds of thousands
of people in Borana.

In the West Wellega zone vaccination
was performed in two districts. The area
is characterized by humid and tropical cli-
mate with average annual rainfall of
2200mm. The altitude range of the zone is
1000m to 2000m above the sea level with
mean annual temperature ranging from 12
to 28° C. Sedentary mixed crop-livestock
farming is the dominant economic activity
encountered across the zone.

In South Omo zone the campaign
covered 5 districts. The area is character-
ized by dry to sub-humid climate with mixed
farming dominated by pastoral livestock pro-
duction.

Study animals

A total of 296,228 cattle vaccinated
with CBPP vaccine derived from T1/44 dur-
ing the campaign were the subjects of the
study. The cattle type reared in the Borana
zone was the Borana breed (type). The dom-
ninant cattle breed (type) in west Wellega zone
was Horro cattle. The cattle breed or type
vaccinated in South Omo zone was Mursi
cattle. All of the cattle breeds (types) included
in the study belong to the African zebu (Bos
indicus) species.

Vaccines and their management

Live attenuated CBPP vaccines in
lyophilized form prepared from strain T1/44
were used during the campaigns. The
vaccines were produced from Pan African
Veterinary Vaccine Center (PANVAC) -EMVT
CBPP reference seed strain denominated
T1/44/2 (batch pan-002) prepared at
PANVAC, Debrezeit, Ethiopia in June 1996
from original strain-T1M44 (16/11/70,
Kevevapi, Muguga, Kenya) with two pas-
sages in liquid medium. A working seed lot
denominated was prepared from the T1/44/
2 (pan-002) in liquid medium and stored in
lyophilized form. All batches of inocula (pro-
duction seed) and final products were pre-
pared from this working seed with two addi-
tional passages in liquid medium. The
batches of vaccines used during the cam-
paign were PL2/97 and PL12/97 in Borana,
PL3/99 in Western Wellega and PL8/99 in
South zones respectively.

Data Collection and Analysis

Data concerning the post vaccinal
complication were obtained from preliminary
field observation and official sources. The
field observation provided figures on attack
rates, mortality and case-fatality rates, and
costs of treatment of the affected animals
was undertaken. The diameter of the swell-
ing was measured using a ruler. Clinical find-
ings encountered were recorded. The offi-
cial sources of data were the record books,
case reports and veterinary personnel. The
confidence interval for attack rate, mortality
and case-fatality rates and Chi-square val-
ues were calculated using standard epide-
miological methods, while cost analysis
associated with the post-vaccinal reaction
was estimated based on the average local
prices of each classes of animals and aver-
age cost of treatment offered to affected
animals.

Results

Clinical findings

The preponderant clinical findings
were circumscribed swelling at the site of
inoculation (which was thick, edematous and painful) that became firm and necrotic after sloughing of the skin or led to abscessation due to secondary bacterial infection. In some animals the swelling was extensive covering the whole neck area and extending down the fore limbs and dewlaps and was followed by death. The severely affected animals were febrile (40-41°C). Their visible mucous membranes were hyperemic. Inanepetence and loss of body weight were common sequelae. The mean time for the development of swelling was 3-21 days post inoculation in both Borana and South Omo zones. In affected areas of Western Wellega zone the reaction developed within 10-12 days post immunization even though few animals developed the lesion 3 months later. The average size of the circumscribed swelling was 5-20cm in diameter. Bigger swellings, which were as large as 40cm in diameter however, were seen in South Omo zone. Treatment with antibiotics especially oxytetracyclins resulted in recovery in most of timely treated cases. The complication took about 14 days to abate unless it culminated in death or exacerbated with secondary bacterial infection.

**Occurrence of the Reaction**

A total of 296 228 cattle (176750, 81788 and 37710 Borana, South Omo and Western Wellega respectively) were vaccinated. Among those vaccinated a total of 3010 cattle (413, 1120 and 1477 cattle in Borana, South Omo and Western Wellega respectively) developed post-vaccinal reaction (Table 1). The overall attack rate was 1.02% (95% C.I.: 1.024). While the mortality and case-fatality rates were 0.17% and 16.5% respectively. The post-vaccinal reaction attack rate was 0.23%, 1.37% and 3.91% respectively.

**Table 1.** Attack rates, mortality and case-fatality rates due to post-vaccinal reaction in the zones investigated.

<table>
<thead>
<tr>
<th>Areas studied</th>
<th>Borana</th>
<th>W. Wellega</th>
<th>S. Omo</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaccinated Population</td>
<td>176750</td>
<td>37710</td>
<td>81788</td>
<td>296228</td>
</tr>
<tr>
<td>Number Affected</td>
<td>413</td>
<td>1477</td>
<td>1120</td>
<td>3010</td>
</tr>
<tr>
<td>Number Died</td>
<td>41</td>
<td>283</td>
<td>173</td>
<td>497</td>
</tr>
<tr>
<td>Attack rate (%)</td>
<td>0.23</td>
<td>3.91</td>
<td>1.37</td>
<td>1.02</td>
</tr>
<tr>
<td>Mortality (%)</td>
<td>0.023</td>
<td>0.75</td>
<td>0.21</td>
<td>0.17</td>
</tr>
<tr>
<td>Case-Fatality (%)</td>
<td>9.9</td>
<td>19.2</td>
<td>15.4</td>
<td>16.5</td>
</tr>
</tbody>
</table>

χ²=4331.47

χ²=994.256

χ²=21.43

P<0.001
in Borana, South Omo and Western Wellega zones respectively. The highest case-fatality rate (19.2% with 95% C.I. of 19.196, 19.204) was observed in West Wellega zone (Table 1) while the lowest rate was recorded in Borana zone.

The attack rate, the mortality and case-fatality rates were significantly higher (p<0.001) in West Wellega zone than the remaining two zones. Within each zone the occurrence of the reaction with associated mortality and case-fatality rates varied greatly among different districts (Table 2). The highest case-fatality rate (35.8% with 95% C.I. of 35.812, 35.828) was recorded in Kuraz district of South Omo zone. Similar higher rates were encountered in Dirre and Laloasbi districts of Borana and West Wellega zones respectively.

The associated economic loss

A total of 3010 cattle succumbed to illness due to post-vaccinal complication. Among these diseased cattle, 497 died. The price of each age and sex groups of cattle affected was not available from Borana and South Omo zones for indicated periods. Lest taking the average price of cattle from West Wellega zone, one can estimate the loss due to direct mortality. On top of the direct economic loss arising from cattle death and cost of treatment there had been a significant depression of production mainly milk production, traction power, manure, body weight, etc. A direct economic loss amounting to ETB $318151.48 (Table 3.)

<table>
<thead>
<tr>
<th>Zone</th>
<th>District</th>
<th>No. Vaccinated</th>
<th>No. Affected</th>
<th>No. Died</th>
<th>Attack Rate(%)</th>
<th>Mortality (%)</th>
<th>Case-fatality(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>South</td>
<td>Bonatsemai</td>
<td>31681</td>
<td>226</td>
<td>41</td>
<td>0.84</td>
<td>0.13</td>
<td>15.4</td>
</tr>
<tr>
<td></td>
<td>Salamago</td>
<td>10000</td>
<td>383</td>
<td>57</td>
<td>3.83</td>
<td>0.57</td>
<td>14.9</td>
</tr>
<tr>
<td>South</td>
<td>Bakoghzair</td>
<td>12000</td>
<td>40</td>
<td>2</td>
<td>0.33</td>
<td>0.017</td>
<td>5.00</td>
</tr>
<tr>
<td>Omo</td>
<td>Kuraz</td>
<td>15600</td>
<td>201</td>
<td>72</td>
<td>1.9</td>
<td>0.46</td>
<td>35.82</td>
</tr>
<tr>
<td></td>
<td>Hamar</td>
<td>12507</td>
<td>231</td>
<td>1</td>
<td>1.84</td>
<td>0.008</td>
<td>0.43</td>
</tr>
<tr>
<td></td>
<td>Dirre</td>
<td>30720</td>
<td>66</td>
<td>14</td>
<td>0.21</td>
<td>0.045</td>
<td>21.2</td>
</tr>
<tr>
<td></td>
<td>Yabello</td>
<td>41850</td>
<td>133</td>
<td>4</td>
<td>0.32</td>
<td>0.0096</td>
<td>3.00</td>
</tr>
<tr>
<td>Borana</td>
<td>Teltele</td>
<td>27200</td>
<td>68</td>
<td>7</td>
<td>0.25</td>
<td>0.025</td>
<td>10.3</td>
</tr>
<tr>
<td></td>
<td>Areno</td>
<td>76980</td>
<td>146</td>
<td>16</td>
<td>0.19</td>
<td>0.02</td>
<td>11</td>
</tr>
<tr>
<td>Western</td>
<td>Manasibib</td>
<td>26360</td>
<td>887</td>
<td>135</td>
<td>3.4</td>
<td>0.51</td>
<td>15.2</td>
</tr>
<tr>
<td>Wellega</td>
<td>Laloasabi</td>
<td>11350</td>
<td>590</td>
<td>148</td>
<td>5.2</td>
<td>1.3</td>
<td>25.1</td>
</tr>
</tbody>
</table>
### Table 3. Direct economic loss due to CBPP post-vaccinal reaction in the affected zones.

<table>
<thead>
<tr>
<th>No.</th>
<th>Type of cost</th>
<th>Data used for calculation</th>
<th>W. Wellega</th>
<th>South Omo</th>
<th>Borana</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mortality</td>
<td>- Price of cattle per age/sex at Mendi and Inango markets.</td>
<td>ETB 145 030</td>
<td>ETB 89 288.76</td>
<td>ETB 21 160.92</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Mortality rate in vaccinated animals per age/sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Treatment costs</td>
<td>- The population of affected cattle.</td>
<td>ETB 24 665.90</td>
<td>ETB 18 704</td>
<td>ETB 6 897.10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Average cost per treated animal (16.7 birr per animal).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Other costs</td>
<td>Fuel and lubricants per diem.</td>
<td>ETB 12 354.80</td>
<td>Not available</td>
<td>Not available</td>
</tr>
</tbody>
</table>

**Total** 318 151.48

### Discussion

The clinical findings encountered in affected animals were typical features of CBPP-post vaccinal reaction and in consistent with CBPP post-vaccinal reaction termed Willem’s reaction has been well documented since mid 19th century (Litamo, 2003). Therefore the complications encountered during the vaccination campaigns were the classical Willem’s reactions.

The attack rate, mortality and case-fatality rates were significantly (p<0.001) higher in Western Wellega zone. This difference was due to the difference in breeds of cattle in the respective areas. That is, the Horro breeds of Western Wellega zone were found to be more susceptible than the other two breeds of cattle. The variation in sensitivity between different breeds of cattle to the CBPP post-vaccinal reaction was described. The highest case-fatality rate (19.2% with 95% C.I. of 19.196, 19.204) observed in West Wellega zone showed that the breeds of cattle reared in the area are more sensitive to the complication than the other breeds. They are more likely to die from the attack of the complication. This difference could be confounded by the inferior body conditions resulting from mal-nutrition. In Western Wellega zone particularly in the affected districts, there was extensive and severe termite infestation and degradation of rangeland. As a result animals in the area were under nourished due to range biomass reduction and almost all were highly emaciated and debilitated. The lower mortality rate in Borana could also be due to timely treatment of the affected animals with antibiotics. 93% of the affected cattle recovered after receiving antibiotic treatment.
Despite the use of vaccines of the same batch derived from the same seed strain the incidence of the reaction with associated mortality and case-fatality rates varied greatly among different districts within the same zone where the cattle population was more or less homogenous (the same breed). The variation was due to difference in sensitivity to the complication among herds and individuals of the same breed. Such individual and within herd variations will be a hindrance to vaccination campaign because of possible unpredictable reactions and consequent mortalities. Within herd difference in susceptibility to CBPP post-vaccinal reactions has been documented.\(^7\)\(^{10}\)

In eastern and southern African countries where T1/44 has been used for the last three decades as vaccine seed strain, post-vaccinal reaction of 1/10,000 (0.0001%) was recorded. In Namibia, where strict subcutaneous route was used over the 11th rib mortality due to post-vaccinal complication was found to be 6 out 500,000, which is equivalent to 0.0012%.\(^{12}\) The occurrence of the complication in fewer woredas of South Omo Borana zones were closer to this figure, though the incidences of the reaction as well as the mortality and case fatality rates recorded in this study seem higher than the previous reports. One factor, which could contribute to this variation, is the site and route of administration of the vaccine. CBPP vaccines (prepared from T1/44) should be administrated stiictly into subcutaneous tissues. Infiltration and injection into intramuscular tissues will increase the probability of occurrence of Willem’s reaction and resultant death. This case was seen in South Omo zone where post mortem examination of dead cattle revealed intramuscular inflammatory infiltration and swelling which indicates that the vaccine was inoculated intramuscularly. In all the three zones the commonest site of inoculation was cervical tissue (that was one of the forbidden sites for CBPP vaccine administration)\(^{10}\). Cervical tissues do have greater sensitivity to T1/44 vaccines and are not recommended area of delivery. On top of their senstivity, the close existence of the skin and muscular tissues of the neck region allows easy infiltration into the intramuscular tissues. For practicality subcutaneous tissues behind the shoulder blade over the 11th rib is recommended site for field use. Besides reducing the possibility of mortality following post-vaccinal reaction inoculation at this site has no negative impact on the future use of draft oxen. Tissues over the neck area become necrotized, dry and friable as a result of which draft oxen fail to pull implements for farmland preparation.

Strict adherence to the use of sharp needles with indicated gauge size and length is important to minimize the incidence of the reaction. It is crucial to switch the needles after inoculation of every 10-20 cattle and the used needles should be washed, sterilized in boiling water and deeped in ethyl alcohol (as ethyl alcohol has no effect on Mycoplasma mycoides mycoides Sc)\(^{11}\) Only freshly opened, sterile, disposable needle to be used to withdraw vaccine from bottle. This needle should not be used to inoculate cattle. Failure to respect these procedures can cause contamination of the vaccine and inoculation of contaminants into animals. In all the investigated areas these procedures were not respected. Hence, abscessation due to secondary bacterial complication aggravated the situation of the reaction. In the absence of these precautions, T1/44 strains caused post-vaccinal reactions, which could affect 2 to 3% of the vaccinated animals\(^{10}\).

Under normal condition CBPP vaccines need to be delivered to healthy animals. This situation, however, is difficult
to attain at the field level leading to only partial vaccination in heavily contaminated herd. Normally some group of animals become carriers, while certain proportions could be incubating the disease, in both cases, the post-vaccinal reaction is expected to be severe. All the three areas considered in this investigation are CBPP endemic areas where both carriers and incubating animals were likely to be vaccinated. Moreover, both South Omo and Western Wellega zones are endemic areas for precarious diseases like trypanosomosis and piroplasmosis, which could exacerbate the situation of post-vaccinal reaction.

As a result of the occurrence of post-vaccinal reactions, the planned vaccination campaign had been discontinued. Hence out of the stipulated 1,000,000 Borana cattle only 549,068 (58%) were vaccinated. Similarly only 3% and 19.8% of cattle were immunized before interruption of the campaign in Western Wellega and South Omo respectively. This led to continuance of outbreaks of CBPP that attacked thousands of animals. This is particularly true in Western Wellega zone where active outbreaks is seen in different districts. Since the complication was strange for the livestock owners they became suspicious and reluctant to get their animals vaccinated against other endemic and epidemic diseases. Other than loosing their confidence on the veterinary services, the farmers refused to have their children immunized against different human diseases. Generally, the attitudes of the livestock owners towards the veterinary services and other extension or development interventions have been negatively affected.

There are few farmers who become complete destitute owing to the death of all their cattle. Even though data is lacking on the estimate of the price of each category of animals died in Borana and South Omo zones, the loss entailed due to the post-vaccinal complication was desperate. It caused food insecurity at the household level though its impact at the zonal or national level seems insignificant relative to the impact of the outbreaks.

Due to unavailability of certain data like the age and sex, price of age and sex groups of cattle during the period when the complication arose, one must be aware that the result of economic loss in this investigation lacks precision. Therefore the same average cattle price obtained from Western Wellega zone was considered for all the three zones. Certain production losses were difficult to express in monetary value because of the lack of methods to do so. These included traction power (the major production loss in the agro-pastoral areas of South Omo zone and Western Wellega zone) and others like abortion and body weight loss. Owing to these constraints, the economic impact that the post-vaccinal complication posed on the livestock owners was underestimated.

The relative efficacy vaccine produced from T1/44 made it the seed strain of choice to continue to use it in combating this rampant disease. Thus, adherence to all precautions during manufacture and field use is highly recommended.

References

4. A.W. Turner (1954). Epidemiological characteristics of bovine contagious pleuropneumo-


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As a result of this massive campaign, the livestock population in the area was drastically reduced. However, the disease continued to spread, and by the end of the year, 25% of the cattle population was killed.

The campaign was conducted in two phases: the first phase targeted the high-risk areas, and the second phase covered the entire district. The campaign was successful, and the number of cases declined significantly.

The implementation of the campaign was challenging due to the large scale of the area and the need for coordination among different stakeholders. The campaign was successful due to the cooperation of all stakeholders, including the local authorities, the veterinary services, and the livestock owners.

The campaign was designed to reduce the prevalence of the disease and to control its spread. The campaign was successful in achieving its goals, and the disease was brought under control.

The campaign had a significant impact on the livestock owners, who were able to recover from the losses incurred due to the disease. The campaign had a positive impact on the local economy, as the disease affected the agricultural productivity of the region.
SEROPREVALENCE OF BRUCELLOSIS IN CAMELS (CAMELUS DROMEDARIUS) IN BORENA LOWLAND, SOUTHERN ETHIOPIA

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²Faculty of Veterinary Medicine, Addis Ababa University, Ethiopia
³National Animal Health Research Center, Sebeta, Ethiopia.

SEROPREVALENCE DE LA BRUCELLOSE CHEZ LES DROMADAIRES (CAMELUS DROMEDARIUS) DANS LA PLAINE DE BORENA AU SUD DE L'ETHIOPIE

Résumé

Une étude transversale a été menée d’août 2003 à janvier 2004, afin d’évaluer la séroprévalence de la brucellose cameline et les facteurs de risque y afférents dans deux districts de la plaine de Borena au sud de l’Éthiopie. Les deux districts étaient choisis à dessein, tandis que des associations de pasteurs et des animaux d’un troupeau dans les deux districts étaient sélectionnés au hasard grâce à un échantillonnage de groupe. On a prélevé du sang à 3218 dromadaires âgés de deux ans et plus. Tous les échantillons de sérum étaient examinés à l’aide du Test d’agglutination sur lame au Rose Bengal (RBPT). Les échantillons de sérum positifs étaient ensuite analysés avec le Test de fixation du complément (CFT) pour confirmation. Des anticorps anti-Brucella étaient détectés chez 1,8% des dromadaires examinés (58/3,218). Seize pour cent des troupeaux (40/250) avaient un animal (ou plus) positif pour la brucellose. L’effet du sexe a été constaté comme étant important pour la séroprévalence (p<0,05) avec un ratio de probabilité 2,3 fois plus élevé chez les femelles que chez les mâles (95% ; IC = 1,1 – 5,3). Les jeunes dromadaires (2 à 4 ans) avaient statistiquement des réacteurs plus faibles que les dromadaires adultes (p<0,05), le ratio de probabilité étant 2,2 fois plus faible chez les jeunes (95% ; IC = 1,1 – 4,6). De même, il y avait une augmentation significative de la séropositivité par rapport à l’accroissement de la taille du troupeau (p<0,05).

Summary

A cross-sectional study was undertaken from August 2003 to January 2004 to estimate the seroprevalence of camel brucellosis and associated risk factors in two districts of Borena lowland, southern Ethiopia. The two districts were selected purposively whereas pastoral associations and animals in a herd in the two districts were selected randomly using cluster sampling. Blood samples were collected from a total of 3218 camels that were two years of age and above. All serum samples were initially screened by the Rose Bengal Plate Test (RBPT). Positive serum samples were further tested by the Complement Fixation Test (CFT) for confirmation. Brucella antibodies were detected in 1.8% (58/3218) of the camels tested. Sixteen percent of the herds (40/250) had one or more animals positive for brucellosis. The effect of sex was observed to be significant for seroprevalence (p<0.05) with odds ratio of 2.3 (95% CI = 1.1 – 5.3) times higher in females than male camels. Young animals (2 to 4 years) had statistically lower reactors than adult camels (p<0.05), the odds of ratio being 2.2 (95% CI = 1.1 – 4.6) times lower in young camels. Similarly, there was a significant increase in seropositivity with respect to increasing herd size (p<0.05).
Introduction

Brucellosis is perhaps one of the most widespread and economically important zoonotic diseases in tropical and subtropical regions\(^1\). The prevalence is generally low in countries with extensive camel management system whereas prevalence is higher in intensive camel production system where animals are kept in a farm\(^2\,^3\).

Previous serological surveys on brucellosis in selected camel rearing areas of Ethiopia showed a prevalence of 4.2% to 5.5%\(^4\,^5\,^6\). There are about 467,119 camel populations in the Borena lowlands of which 328,080 and 11,036 camels are being kept in Liben and Yabello districts respectively\(^7\). The present study was undertaken to estimate the seroprevalence of brucellosis in camels and associated risk factors in the two districts of Borena lowland, southern Ethiopia.

Materials and Methods

Study areas

The study was conducted in Liben and Yabello districts of Borena lowlands in southern Ethiopia about 600 km from Addis Ababa. The Borena area represents a vast lowland area of southern Ethiopia covering about 95,000 km\(^2\). The climate is generally semi-arid with annual average rainfall ranging from 300 to 700 mm and annual mean daily temperature varying from 19\(^\circ\)C to 24\(^\circ\)C. Animal husbandry is characterized by extensive pastoral production system and seasonal mobility\(^7\).

Study design

The two districts were selected purposively due to easier accessibility and availability of high camel population. There are 38 and 30 pastoral associations (subadministrative units) in Liben and Yabello districts of which 16 and 6 associations respectively were randomly selected based on their camel population. A total of 250 camel herds (i.e. clusters) in the 22 of 68 pastoral associations were sampled by a cluster sampling (about 5% of camel herds per pastoral association). All animals in a herd that were two years of age and above were sampled. The expected prevalence of brucellosis of 4.5%\(^4\,^6\) and reported average herd size of 14 animals per herd in the areas were used to determine the sample size. Blood samples were collected from the jugular vein of 3218 camels in 250 herds using plain vacutainers and needles. The blood samples were allowed to clot at room temperature and sera were separated by centrifugation. Serum samples were stored at -20\(^\circ\)C until laboratory test was performed.

Rose Bengal Plate Test (RBPT)

All sera samples were initially screened by the Rose Bengal Plate Test (RRBPT) using RBPT antigen (Institut Pourquier, France). The test procedure recommended by Alton et al.\(^8\) was followed. Briefly, 30 ml of the RBPT antigen and 30 ml of the test serum were placed alongside on the plate, and then mixed thoroughly. The plate was shaken for 4 minutes and the degree of agglutination reactions were read and recorded.

Complement Fixation Test (CFT)

Positive sera with the RBPT were further tested with CFT for confirmation using standard Brucella abortus antigen (Central Veterinary Laboratory, Weybridge, UK) at the National Animal Health Research Center (NAHRC), Sebeta, Ethiopia. The CFT test and reagent preparations were carried out
as outlined by Alton et al.\textsuperscript{8} and OIE\textsuperscript{9}. Sera with at least 50% fixation of complement (2+) at a dilution of 1:10 and above were considered as positive.

Results

Of the total 3218 camels examined for brucellosis 1.8% (58/3218) were positive. The RBPT identified 72 (2.2%) positive reactors out of 3218 serum samples of which 58 (1.8%) were confirmed to be positive by CFT. Table 1 shows the seroprevalence of camel brucellosis in the two districts with respect to age and sex. A relatively high prevalence of brucellosis was recorded in Yabello (2.0%) than in Liben (1.7%) which was not statistically significant. In both districts young animals had low number of reactors (ranging from 0.8% to 1.4%) than adults (ranging from 2.1% to 2.2%).

A significantly high prevalence of camel brucellosis was recorded in females 2.1% (52/2528) compared to males 0.9% (6/690), (p<0.05) with the likelihood of brucellosis occurrence 2.3 times higher in females than in males. Adult camels (>4 years of age) had high prevalence of brucellosis than young animals (p<0.05), the odds of seroprevalence being 2.2 times higher in adults.

Table 2 shows the risk factors for the occurrence of brucellosis in camels. Herd size was classified into three categories: small 3 – 10, medium 11 – 20 and large > 20 animals. The number of herds in the small, medium and large categories includes 113, 93 and 44 respectively. An increasing seropositivity was recorded with respect to increasing herd sizes (p<0.05). Multivariate analysis of risk factors showed that herd size was the major risk factor for the occurrence

<table>
<thead>
<tr>
<th>Camels (2 - 4 years of age)</th>
<th>Camels (&gt; 4 years of age)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td><strong>No. of Samples</strong></td>
</tr>
<tr>
<td><strong>Liben District</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>280</td>
</tr>
<tr>
<td>Female</td>
<td>436</td>
</tr>
<tr>
<td>Subtotal</td>
<td>716</td>
</tr>
<tr>
<td><strong>Yabello District</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>168</td>
</tr>
<tr>
<td>Female</td>
<td>190</td>
</tr>
<tr>
<td>Subtotal</td>
<td>358</td>
</tr>
<tr>
<td>Total</td>
<td>1074</td>
</tr>
</tbody>
</table>
of seropositivity to brucellosis in camels. The overall herd level and within herd seroprevalence of brucellosis for the study areas were 16% and 9.5%, respectively. The herd level and maximum within herd prevalence recorded in this study were 14.5% (95% CI = 9.6 – 20.7) and 45.5% (5 out of a herd of 11 animals) in Liben and 19.2% (95% CI = 11.2 – 29.7) 12.5% in the other district. There was a highly significant increase in brucellosis seroprevalence with respect to herd size (P <0.01). The risk for the occurrence of seropositivity was 2.8 times higher in medium and 4.9 times higher in large herds than small sized herds.

Discussion

The seroprevalence of 1.8% of brucellosis in camels from the present study was similar to the previous reports from different countries. However, low seroprevalence of brucellosis has been reported previously in Ethiopia, Kenya, Nigeria, Sudan, Somalia, Kuwait, and Saudi Arabia. The seroprevalence of brucellosis in camels is low in extensively kept pastoralists camels. Thus, prevalence ranging between 2 and 5% were reported from most countries where camels are kept by pastoralists. On the other hand, it was reported as high as 8 to 15% in intensively kept camels especially in Saudi Arabia and Kuwait. In intensive production systems, large herds together with overcrowding in restricted areas provide more chances of contact between infected and susceptible animals leading to increased likelihood of infection.

Even under pastoral conditions, individual herds could have an appreciably higher brucellosis than the regional risk. A seroprevalence of camel brucellosis in cer-

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Category</th>
<th>Total No. of Samples</th>
<th>95%CI</th>
<th>OR (95%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Male</td>
<td>690</td>
<td>6 (0.9)</td>
<td>0.3 - 1.9</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>2528</td>
<td>52 (2.1)</td>
<td>1.5 - 2.7</td>
</tr>
<tr>
<td>Age</td>
<td>2 – 4 years</td>
<td>1074</td>
<td>11 (1.0)</td>
<td>0.5 - 1.8</td>
</tr>
<tr>
<td></td>
<td>&gt; 4 years</td>
<td>2144</td>
<td>47 (2.2)</td>
<td>1.6 - 2.9</td>
</tr>
<tr>
<td>Herd size</td>
<td>3 – 10</td>
<td>777</td>
<td>9 (1.2)</td>
<td>0.5 - 2.2</td>
</tr>
<tr>
<td></td>
<td>11 - 20.</td>
<td>1523</td>
<td>24 (1.6)</td>
<td>1.0 - 2.3</td>
</tr>
<tr>
<td></td>
<td>&gt; 20</td>
<td>918</td>
<td>25 (2.7)</td>
<td>1.8 - 4.0</td>
</tr>
<tr>
<td>Parity</td>
<td>No parturition</td>
<td>198</td>
<td>4 (2.0)</td>
<td>0.6 - 5.5</td>
</tr>
<tr>
<td></td>
<td>Single parity</td>
<td>371</td>
<td>7 (1.9)</td>
<td>0.9 - 3.8</td>
</tr>
<tr>
<td></td>
<td>More than one</td>
<td>1333</td>
<td>32 (2.4)</td>
<td>1.6 - 3.8</td>
</tr>
</tbody>
</table>
tain camel herds in Sudan was reported to range from 26.5 to 30\%\(^3\) while another study reported a seroprevalence ranging from 14\% to 43.9\%\(^{21}\). Likewise, within herd prevalence ranged from 2.7\% to 45.5\% with average of 9.5\% recorded in the present study. Previously a 1.2\% prevalence was reported even though the number of animals examined were very few (2 out of 170 were positive) from Borena\(^6\). Low prevalence of camel brucellosis in the present study was probably due to the existence of relatively higher number of small sized herds (113 of 250 herds) as compared to larger herd size kept in the eastern Ethiopia. The existing tradition of isolating calves and aborted females from other animals in the herd perhaps might reduce the risk of infection. Long calving intervals in combination with late age at first calving in dromedaries kept under extensive production system\(^{26}\) limit transmissions within and subsequently among herds particularly in areas with low prevalence\(^{24}\).

The present study indicated that seroprevalence was significantly higher in female than male dromedaries with the likelihood of occurrence of 2.3 times higher in females than male animals. Our result was in agreement with the reports from Sudan\(^{26}\) and Nigeria\(^{19}\). Other authors reported equal rate of occurrence of *Brucella* antibodies between both sexes\(^{10,14,18}\). Even though the number of female camels was too small to make a comparison, Okoh\(^{13}\) reported a high prevalence of brucellosis in male camels.

A statistically significant difference was observed between young and mature animals (p<0.05), the probability of brucellosis occurrence being 2.2 times higher in adult than young camels. A strong positive correlation was observed with increasing age and reactor rates, the correlation coefficient This was in agreement with the findings of others\(^6,11,21\). The current study also illustrated that herd size was significantly associated with brucellosis in camels with odds of brucellosis occurrence increasing by 40% and 140% when small herd is compared with medium and large herds. As herd size increases, the chance of contact between animals increases leading to more chances of infection\(^{24}\), which is particularly more important during calving or abortion where most brucellosis contamination could occur\(^{26}\).

Mixed herding and frequent contact with small ruminants and cattle could also be contributing factors to the occurrence of brucellosis. Herders in Borena and elsewhere invariably keep small ruminants and cattle alongside with camels. It has been reported that there could be high chance of brucellosis transmission from these ruminants to dromedaries as they live in free range in promiscuity in the bush and at water points\(^{22}\). Contact especially between dromedaries and small ruminants were more incriminated for the transmission of brucellosis to camels\(^3,11\). The seroprevalence status of brucellosis in Borena cattle was reported to be 6.2\% and 3.5\%\(^{27}\) from ranches and pastoral cattle, respectively. Brucellosis can also be a health hazard to humans particularly to pastoral households who in many ways are exposed to the various sources of infection\(^{24}\). AbouEisha\(^{11}\) reported 1% brucellosis seroprevalence among nomadic people. Camel owners of the study area consume raw milk, do delivery assistance, clean newborns, assist suckling and carry the young from field to home without any protection. Results of the present study provide information on the current status of camel brucellosis in the Borena lowland pastoral areas and the risk factors that contribute to the occurrence and maintenance of brucellosis in camels.
Acknowledgements

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References


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FACTORS ASSOCIATED WITH BOVINE UDDER INFECTIONS IN SMALLHOLDER DAIRY FARMS IN ETHIOPIA

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FACTEURS LIES AUX INFECTIONS DE LA MAMELLE BOVINE DANS LES PETITES EXPLOITATIONS LAITIERES EN ETHIOPIE

Résumé

Une étude transversale a été menée de février 2002 à décembre 2002, afin d'éclaire la prévalence et les facteurs liés à l'infection de la mamelle. Au total, 336 vaches lactantes de race Arbi, dans le district de Adame-Tulu en Ethiopie, ont fait l'objet d'étude à l'aide du « California Mastitis Test » (CMT) et de l'examen clinique de la mamelle. L'étude consistait en un échantillonnage à divers niveaux avec quinze villages choisis au hasard dans le district. Les vaches lactantes de six ménages randomisés de chaque village sont regroupées. Parmi les vaches lactantes examinées, 131 (38,9%) avaient des signes positifs de la mammité; 41 (12,2%) avaient la mammité clinique et 90 (26,8%) la mammité infraclinique. Il a été indiqué que la mammité était fortement liée à l'état corporel (χ² = 10,5 ; P<0,01), elle était plus fréquente (46,1% ; OR=2,7 ; IC= 2 - 3,7) chez les vaches ayant un mauvais état corporel mais affectait moins celles relativement en bon état (23,5%). Type (χ² = 7,8 ; P<0,01). Les conditions d'hygiène de la laiterie avaient beaucoup d'impacts sur la prévalence de la mammité (χ² = 47 ; P<0,0005). Les vaches d'un grand troupeau étaient six fois plus exposées (OR = 5,7 ; IC = 3,8 - 8,2) à l'infection de la mamelle que celles issues d'un petit troupeau (56,9% contre 26,1%). Les lésions de la mamelle/du trayon dues surtout aux tiques étaient les principaux facteurs qui prédisposent à la mammité dans la région. Les vaches avec des cas répétés d'infection de la glande mammaire étaient sept fois plus exposées (OR = 7,2 ; IC = 5 - 10,4) au risque de réinfection que celles qui n'étaient pas infectées auparavant (χ² = 44,9 ; P <0,001) (40,8% contre 22%). La mauvaise hygiène et le peu d'attention accordée aux soins des glandes mammaires étaient les facteurs importants de forte prévalence de la mammité.

Mots-clés: Mammite, vaches lactantes, facteurs de risque, race locale, petite exploitation laitière, Adame-Tulu, Ethiopie.

Summary

A cross sectional study to elucidate the prevalence and factors associated with udder infection was carried out from February 2002 to December 2002. A total of 336 milking cows of Arsi breed in Adame-Tulu district, Ethiopia were studied using California Mastitis Test (CMT) and clinical examination of udder. The study involved a multistage sampling with fifteen randomly selected villages from the district. Milking cows from six households selected randomly from each village were sampled by cluster sampling. Of the total milking cows examined, 131 (38.9%) showed positive signs of mastitis; 41 (12.2%) clinical and 90 (26.8%) sub clinical mastitis. Mastitis was reported to be significantly (χ²=10.5, P<0.01) associated with body condition, being higher (46.1 %, OR=2.7 (CI=2.0-3.7)) in cows with poor body condition and lower in those at relatively good status (23.5%). Type (χ²=7.8, P<0.01). Hygienic condition of dairy house significantly influenced mastitis prevalence (χ²=47.0, P<0.0005). Cows maintained in bigger herd size were about six times at higher risk (OR=5.7 (CI=3.8-8.2)) of getting udder infection than those maintained in smaller herd size (56.9% vs. 26.1%). Udder/teat injuries caused mainly by ticks were the major predisposing factors of mastitis in the area. Cows with repeated episodes of mammary gland infection were about seven times (OR=7.2, (CI=5.0-10.4)) at higher risk of re-infection than previously uninfected ones (χ²=44.9, P<0.001 (40.8 %vs. 22.0 %). Poor sanitation of dairy environment and lack of proper attention to health of the mammary glands were important factors for high prevalence of mastitis.

Keywords: Mastitis, milking cows, risk factors, indigenous breed, Smallholder dairy farms, Adame-Tulu, Ethiopie.

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Introduction

Ethiopia has the largest livestock population in Africa with an estimated 35 million Tropical Livestock Units (TLU) including 31 million cattle, 42 million sheep and goats, 7 million equines. Despite this huge livestock resource, the productivity is one of the lowest in the world owing to a multitude of interrelated constraints. Disease is among the major causes of huge economic losses to the national economy besides affecting the livelihood of the farming communities at large. Cows represent the largest proportion of cattle population of the country. FAO estimated that 42% of the total cattle heads for the private holdings are milking cows. However, milk production often does not satisfy the country’s milk requirements due to a multitude of factors. Disease of the mammary glands known as mastitis is among the various factors contributing to reduced milk production. In Ethiopia mastitis is a major and prevalent disease of dairy cows causing huge economic loss as a result of reduction of milk yield and early culling of productive cows.

Studies on mastitis so far conducted in Ethiopia have largely focused on intensive farms that comprise only a proportion of the country’s dairy population. Henceforth, information relating to the magnitude of the problem and the associated influencing factors in smallholder dairy farms that constitute local cows and large proportion of dairy holdings in rural areas is scanty. Such information is important to envisage and design appropriate strategies that would help reduce the prevalence and effects of the disease in the country. This study was thus designed to elucidate the prevalence and factors associated with occurrence of mastitis in indigenous dairy cows of smallholder farms in Adame-Tulu district, Ethiopia.

Materials and Methods

Study Area

The study was carried out from February 2002 to December 2002 in Adame-Tulu district. Adame-Tulu is located in southern Rift Valley in Eastern Shoa at about 225 km South of Addis Ababa. The altitude ranges from 1500-2000 m.a.s.l., and constitutes lowlands, mid highlands and highlands. The area has an average annual rainfall ranging from 800 to 1000mm. The mean annual minimum and maximum temperatures are 10°C and 25°C, respectively. Agriculture, dominated by crop-livestock production system, is the mainstay of the population in the district. Cattle keeping is an important component of animal agriculture. Cattle serve multipurposes which include source of milk, meat, draught power and household income.

Study Animals and Husbandry system

Study animals included 336 local dairy cows belonging to Arsi breed, managed under traditional husbandry practice. Though goats also provide milk particularly in some semi-arid areas, cows are the predominant source of milk in the district. Animals are allowed to graze on natural pasture and occasionally, grasses cut from crop fields are provided. Stable grazing and crop residues also serve as additional sources of feed during post harvest and long dry season. The average number of milking cows holdings per household is three. Depending on their number, each cow is either kept in a separate stall in the living house with family members or maintained in corrals along with other animals. Cows of Arsi breed are relatively
smaller in size and have small udders and short teats. They are hand-milked twice a day during lactation period, which often extends beyond a year and are allowed to dry-off gradually. Milk yield ranges from 300 to 400 kg per lactation.

**Study Design and Selection of Villages, Households and Cows**

A cross-sectional study involving multistage sampling technique was carried out between February 2002 to December 2002. Fifteen villages were selected from the district by simple random sampling technique which involves arbitrary selection of the villages from the list of total villages in the district and this is done in consultation with the experts from the district Ministry of Agriculture. All households owning milking cows within each village were considered as sampling frame (information obtained from the district administrative office) and each household as primary sampling unit. Milking cows from six randomly selected households in each village (by a simple random selection) were sampled by cluster sampling.

In order to determine the sample size, 30% prevalence was assumed from the previous study. At the maximum allowable error of 2.5% and 95% Confidence Interval (CI) the sample size was then calculated to be 336 milking cows based on the formula described by Thrushfield.

**Data Collection**

A semi-structured questionnaire was developed and pretested by the principal investigator and field assistant on 25 randomly selected household heads from five villages in the study area. Data on factors associated with mastitis and the variation in its occurrence and prevalence and mastitis-induced blind mammary quarters in lactating cows were recorded. Data collected were age, stage of lactation, parity, and body condition, type of house and herd size. Udder and milk abnormalities (injuries, tick infestation, and indurations, swelling, milk clots, abnormal secretion etc.) were also recorded.

Age of the animals was determined from birth records and dentition characteristics and categorised as young adults (>3=6 years), adults (>6=10) and old (>10 years). Stage of lactation was categorised as early (1st to 4th months), mid (4th to 8th month) and late (from 8th to the beginning of dry period). Similarly, parity was categorized as few (=3 calves), moderate (4-7 calves) and many (>7 calves). Body condition of cows was rated based on standard body condition scoring technique as poor, moderate and good. The housing condition was categorized as barn/orals, separate stall with smooth ground and separate stall of concrete ground with bedding materials. Some ticks from mastitis cows were collected and identified based on standard morphological descriptions.

**Clinical examination of the Udder**

The udder was first examined visually and then through palpation to detect possible fibrosis, inflammatory swellings, visible injury, tick infestation, atrophy of the tissue and swelling of supramammary lymph nodes. The size and consistency of mammary quarters were inspected for the presence of any abnormalities such as disproportional symmetry, swelling, firmness and blindness. Mammary quarters often became blind when there were repeated infections and no or little treatment was provided. Information related to the previous health history of the mammary quarters and causes of blindness was obtained from
interviews with owners of the farm. Viscosity and appearance of milk secretion from each mammary quarter were examined for the presence of clots, flakes, blood and watery secretions.

**Detection of udder infection**

Udder infection was detected using California Mastitis Test (CMT) and results of clinical inspection of the udder\(^15\). CMT grades were evaluated and the results graded as 0 and 1 for negative and 2 and 3 for positive \(^16\). Udder infection was concluded based on clinical examination, nature and appearances of milk secretion and CMT\(^15\). Accordingly, milk with pus, flakes, clots, blood-tinged watery secretion yet no visible and palpable changes in mammary quarters and acute mastitis with signs of systemic involvement were diagnosed as clinical mastitis. Sub-clinical mastitis was diagnosed based on CMT results\(^15,17\).

**Statistical Analysis**

The prevalence of mastitis relating to specific risk factor was determined using Frequency procedure of SYSTAT\(^18\) as the proportion of mastitis cases out of the total milking cows examined. The degree of association between specific risk factors (age, stage of lactation, parity, body condition, type and hygienic condition of the house, herd size, presence of udder/teat injuries and previous exposure to udder infection) and prevalence of mastitis were investigated by Chi-Square test \((\chi^2)\) Cross-tabulations (Cross tabs-Two-way-Statistics procedure of SYSTAT\(^18\). Similarly, prevalence of mastitis-caused blind mammary quarters was determined as the proportion of blind quarters out of the total quarters examined. The association between specific animal related risk factors (age, stage of lactation and parity) and occurrence of blind mammary quarters was assessed by Chi-Square test \((\chi^2)\) (Cross tabs-Two-way-Statistics procedure of SYSTAT\(^18\). Odds Ratio (OR) was calculated to assess strength of association between specific risk factor and prevalence of mastitis and blind quarters. The significance of OR was determined by constructing 95% Confidence Interval using the formula Ln (OR)±\(Z_{0.025}\) ASE where Ln(OR) represents the value of natural log of OR and ASE Asymptomatic Standard Error (the value of \(Z_{0.025}\) =1.96 at decision power of 0.95)\(^18\). The corresponding antilog of the CI for OR was determined. When CI for OR didn’t include 1.0, then the true odds of categories under specified risk factor differed significantly. In all Chi-Square test \((\chi^2)\) application, probability levels of \(P<0.0005\), \(P<0.05\) and \(P<0.01\) were considered statistically significant. Relative frequency (RF) was determined as the proportion of cases relating to specific category under specific risk factor out of the total cases for the specified risk factor \(^9\).

**Results**

Of the 336 milking cows examined, 131 (38.9%) had mastitis of which 41 (12.2%) were clinical and 90 (26.8%) were subclinical. Age \((\chi^2=36.1, P<0.0005)\), stage of lactation \((\chi^2=10.6, P<0.01)\) and parity \((\chi^2=52.8, P<0.0005)\) showed significant influence on prevalence of mastitis (Table 1). Other details on factors associated with mastitis are shown in Table 1.

There was significant degree of association \((\chi^2=7.8, P<0.01)\) between housing condition and prevalence of mastitis (Table 2). Other details are in Table 2.

The overall prevalence of 6.6% blind mammary quarters was reported in the present study. The Prevalence varied significantly between different age groups \((\chi^2=43.2,P<0.0005)\), stage of lactation \((\chi^2=11.9,P<0.005)\) and parity \((\chi^2=26.6, P<0.0005)\) (Table 3). Other details are shown in Table 3.
Table 1. Prevalence of mastitis in Milking cows in Adame-Tulu district as influenced by age, stage of lactation, parity and physical condition of animals.

<table>
<thead>
<tr>
<th>Factor</th>
<th>No. Examined</th>
<th>CM (%)</th>
<th>SCM (%)</th>
<th>Total (%)</th>
<th>$\chi^2$</th>
<th>Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Young adults</td>
<td>101</td>
<td>27(26.7)</td>
<td>11(10.9)</td>
<td>38(37.6)</td>
<td>36.1*</td>
<td>2.6(1.7-3.9)</td>
</tr>
<tr>
<td>Adults</td>
<td>107</td>
<td>6(5.6)</td>
<td>14(13.1)</td>
<td>20(18.7)</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Old</td>
<td>128</td>
<td>8(6.3)</td>
<td>65(50.8)</td>
<td>73(57.0)</td>
<td>5.8</td>
<td>(4.3-8.6)</td>
</tr>
<tr>
<td>Stage of Lactation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early</td>
<td>117</td>
<td>33(28.2)</td>
<td>25(21.4)</td>
<td>49.6</td>
<td>10.6**</td>
<td>2.5(1.8-3.6)</td>
</tr>
<tr>
<td>Mid</td>
<td>109</td>
<td>-</td>
<td>31(28.4)</td>
<td>31(28.4)</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Late</td>
<td>110</td>
<td>8(7.3)</td>
<td>34(30.9)</td>
<td>42(38.2)</td>
<td>1.6</td>
<td>(1.2-2.4)</td>
</tr>
<tr>
<td>Parity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Few</td>
<td>113</td>
<td>30(26.6)</td>
<td>(24)21.2</td>
<td>(19)16.8</td>
<td>52.8*</td>
<td>1.0</td>
</tr>
<tr>
<td>Moderate</td>
<td>102</td>
<td>4(3.9)</td>
<td>17(16.7)</td>
<td>36(35.3)</td>
<td>2.7</td>
<td>(1.7-4.4)</td>
</tr>
<tr>
<td>Many</td>
<td>121</td>
<td>7(5.8)</td>
<td>49(40.5)</td>
<td>76(62.8)</td>
<td>8.4</td>
<td>(5.6-18)</td>
</tr>
<tr>
<td>Physical Condition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>165</td>
<td>26(15.8)</td>
<td>50(30.3)</td>
<td>76(46.1)</td>
<td>10.4**</td>
<td>2.7 (2.0-3.7)</td>
</tr>
<tr>
<td>Moderate</td>
<td>103</td>
<td>13(12.6)</td>
<td>26(25.2)</td>
<td>39(37.7)</td>
<td>1.9</td>
<td>(1.3-2.8)</td>
</tr>
<tr>
<td>Good</td>
<td>68</td>
<td>2(2.9)</td>
<td>14(20.6)</td>
<td>16(23.5)</td>
<td>1.0</td>
<td></td>
</tr>
</tbody>
</table>

*P<0.0005 (highly significant), **P<0.01 (significant), CM = clinical mastitis, SCM = subclinical mastitis, OR = odds ratio.

Discussion

A higher overall prevalence of 38.9% of mastitis was reported in Ethiopian indigenous dairy cows in this study. The previous studies reported 18% and 29% in indigenous breeds from Southern Wollo, North Ethiopia\textsuperscript{4} and Wolayta district, Southern Ethiopia\textsuperscript{10} respectively. This shows an increased tendency of mastitis in indigenous breeds than it was hitherto assumed, which is comparable to previous reports in exotic breeds and their crosses in some parts of the country (Debre-zeit in central, Ethiopia, 39.5%\textsuperscript{5}; Dire-Dawa, Eastern Ethiopia, 36.9%\textsuperscript{6}; Chaffa valley, Northern Ethiopia, 38.65\textsuperscript{4}. The prevalence of clinical (12.2%) and subclinical mastitis (26.8%) recorded is in agreement with previous finings\textsuperscript{4, 5, 19}. The high prevalence of mastitis in local zebu, despite the previous argument that the breed is relatively resistant to udder infection, could be attributed to, poor management, and inadequate animal health services coupled with increased predisposing factors such as high level of tick infestation and teat injury in the area.

The increased prevalence of mastitis with age and parity reported in the present study is consistent with previous reports\textsuperscript{15,17,20} indicating an increase in the prevalence as lactation number and age increase. The age-multiparous-high prevalence relationship is explained to be due to an increase in teat patency and degree and frequency of previous exposure in multiparous old cows\textsuperscript{15,17}. The variation in prevalence of
mastitis between stages of lactation was significant. Early (49.6%) and late (38.2%) lactations were the periods during which higher prevalence was reported as compared to lower (28.4%) prevalence in mid lactation. This finding is in consistent with the previous works\textsuperscript{15, 21}.

The association of poor physical condition of animals and high prevalence of mastitis could have been explained from the fact that physically stressed animals are more susceptible to udder infection due to

Table 2. Prevalence of mastitis in milking cows in Adame-Tulu district as influenced by housing condition, frequency of manure removal, herd size, present and previous health status of udders.

<table>
<thead>
<tr>
<th>Factor</th>
<th>No. Examined</th>
<th>CM (%)</th>
<th>SCM (%)</th>
<th>Total (%)</th>
<th>$\chi^2$</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Housing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Condition</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barns/corals</td>
<td>153</td>
<td>22(14.4)</td>
<td>45(29.4)</td>
<td>67(43.8)</td>
<td>7.8**</td>
<td>2.2 (1.6-3.0)</td>
</tr>
<tr>
<td>Separate stall</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With smooth ground</td>
<td>81</td>
<td>8 (9.9)</td>
<td>13 (16.0)</td>
<td>21 (25.9)</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Separate stall of concrete</td>
<td>102</td>
<td>11 (10.8)</td>
<td>32 (31.4)</td>
<td>43 (42.0)</td>
<td>2.1(1.4-3.1)</td>
<td></td>
</tr>
<tr>
<td>Ground with bedding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Materials</strong></td>
<td></td>
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</tr>
<tr>
<td><strong>Frequency</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of manure</td>
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</tr>
<tr>
<td><strong>Removal</strong></td>
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</tr>
<tr>
<td>Every day</td>
<td>120</td>
<td>6 (5.0)</td>
<td>14 (11.7)</td>
<td>20 (16.7)</td>
<td>47.0*</td>
<td>1.0</td>
</tr>
<tr>
<td>Every week</td>
<td>113</td>
<td>16 (14.2)</td>
<td>32 (28.3)</td>
<td>48 (42.5)</td>
<td>3.7 (2.5-5.3)</td>
<td></td>
</tr>
<tr>
<td>Once in a month</td>
<td>103</td>
<td>19 (18.5)</td>
<td>44 (42.7)</td>
<td>63 (61.2)</td>
<td>7.9 (5.5-2.1)</td>
<td></td>
</tr>
<tr>
<td>Or more</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Herd Size</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\leq 10$</td>
<td>134</td>
<td>6 (4.5)</td>
<td>29 (21.6)</td>
<td>35 (26.1)</td>
<td>16.5*</td>
<td>1.0</td>
</tr>
<tr>
<td>&gt;10- $\leq$20</td>
<td>106</td>
<td>15 (14.2)</td>
<td>32 (30.1)</td>
<td>47 (44.3)</td>
<td>2.3 (1.6-3.4)</td>
<td></td>
</tr>
<tr>
<td>&gt;20</td>
<td>96</td>
<td>20 (20.8)</td>
<td>29 (30.2)</td>
<td>49 (56.0)</td>
<td>5.7 (3.8-8.2)</td>
<td></td>
</tr>
<tr>
<td><strong>Udder/ teat injuries</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>232</td>
<td>8 (3.5)</td>
<td>64 (27.6)</td>
<td>72 (31.0)</td>
<td>19.9*</td>
<td>1.0</td>
</tr>
<tr>
<td>Present</td>
<td>104</td>
<td>33 (31.7)</td>
<td>26 (25.0)</td>
<td>59 (56.7)</td>
<td>2.9 (2.3-4.9)</td>
<td></td>
</tr>
<tr>
<td><strong>Previous exposure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To Udder infection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not exposed</td>
<td>209</td>
<td>31(14.8)</td>
<td>15 (7.2)</td>
<td>46 (22.0)</td>
<td>67.0*</td>
<td>1.0</td>
</tr>
<tr>
<td>Exposed</td>
<td>127</td>
<td>10 (7.9)</td>
<td>75 (59.1)</td>
<td>85 (66.9)</td>
<td>7.2 (5.0-10.4)</td>
<td></td>
</tr>
<tr>
<td>Once</td>
<td>7 (70.0)***</td>
<td>6 (8.0)***</td>
<td>13 (15.3)***</td>
<td>29.3*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Twice</td>
<td>3 (30.0)</td>
<td>17 (22.7)</td>
<td>20 (23.5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than two</td>
<td></td>
<td>52 (69.3)</td>
<td>52 (61.2)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CM=Clinical mastitis, SCM=Subclinical mastitis, OR=Odds ratio, *P<0.0005 (highly signifant), **P<0.01(Significant), ***=Relative Frequency (RF)
Table 3. Prevalence of mastitis-induced blind mammary quarters as influenced by age, stage of lactation and parity.

<table>
<thead>
<tr>
<th>Factor</th>
<th>No. Quarters examined</th>
<th>No. Quarters blind</th>
<th>Prevalence (%)</th>
<th>( \chi^2 )</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age Young</td>
<td>404</td>
<td>7</td>
<td>1.7</td>
<td>43.2*</td>
<td>1.0</td>
</tr>
<tr>
<td>Young adult</td>
<td>428</td>
<td>20</td>
<td>4.7</td>
<td>2.8 (1.1-6.9)</td>
<td></td>
</tr>
<tr>
<td>Old</td>
<td>512</td>
<td>62</td>
<td>12.1</td>
<td>7.8 (3.1-19.4)</td>
<td></td>
</tr>
</tbody>
</table>

Stage of Lactation

<table>
<thead>
<tr>
<th>Lactation</th>
<th>No. Quarters examined</th>
<th>No. Quarters blind</th>
<th>Prevalence (%)</th>
<th>( \chi^2 )</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early</td>
<td>468</td>
<td>46</td>
<td>9.8</td>
<td>11.9**</td>
<td>2.2 (1.7-2.8)</td>
</tr>
<tr>
<td>Mid</td>
<td>436</td>
<td>21</td>
<td>4.8</td>
<td></td>
<td>1.0</td>
</tr>
<tr>
<td>Late</td>
<td>440</td>
<td>22</td>
<td>5.0</td>
<td></td>
<td>1.1 (0.4-3.0)</td>
</tr>
</tbody>
</table>

Parity

<table>
<thead>
<tr>
<th>Parity</th>
<th>No. Quarters examined</th>
<th>No. Quarters blind</th>
<th>Prevalence (%)</th>
<th>( \chi^2 )</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Few</td>
<td>452</td>
<td>11</td>
<td>2.4</td>
<td>26.6*</td>
<td>1.0</td>
</tr>
<tr>
<td>Moderate</td>
<td>408</td>
<td>28</td>
<td>6.6</td>
<td>3.5 (2.4-5.1)</td>
<td></td>
</tr>
<tr>
<td>Many</td>
<td>484</td>
<td>50</td>
<td>10.1</td>
<td></td>
<td>5.9 (4.1-9.0)</td>
</tr>
</tbody>
</table>

* P<0.0005 (highly significant), **P<0.005 (highly significant),

an influence on health condition of the gland.

The reported higher prevalence of mastitis in cows maintained in open barns and separate stalls where manure and wet bedding were not removed frequently substantiated the importance of sanitation in the epidemiology of mastitis. Heavy faecal contamination and gradual deposition of wet dirt especially during rainy season enhanced the build up of coliform bacterial infection and transmission. In agreement with our observation, bedding materials were reported to have a crucial role in the microbial contamination of the environment and transmission to infection from animals to animals. In consistent with the previous study reporting that as herd size increases the level of contamination usually increases, in this study milking cows maintained in larger herds were at higher risk of getting udder infection compared to those in smaller herds.

The high prevalence of mastitis associated with udder/teat injuries reported in this study suggests prevailing inadvertence to udder management and health. The abundant ticks might have also contributed to the udder injuries favoring udder infection. Ticks particularly long-hypostome species such as *Amblyomma*, are the major cause of udder damage and exposure to serious secondary bacterial invasion. In envisaging a mastitis control strategy, the role of tick infestation should be given due attention. Previously infected cows were at higher risk of reinfection suggesting non-clearance of past infections. The relatively high occurrence of blind mammary quarters (6.9%) associated with mastitis, which has a direct influence on milk production with a consequent impact on food security signifies the importance of the problem. Though estimation of milk production loss resulting from mammary
quarters dysfunction is beyond the scope of this study, it may not be very difficult to imagine the loss incurred given the unacceptably high proportion of milking cows with non-functioning teats.

The study showed that mastitis was highly prevalent in extensive dairy farms in Ethiopia and is a major health problem of indigenous dairy cows despite the previous opinion that mastitis is a problem of exotic breeds and their crosses. Inadequate hygienic condition of dairy environment, poor animal health service and lack of proper attention to health of the mammary glands were important factors associated with high prevalence of mastitis in the area. Adequate housing with proper sanitation and regular screening for early detection and treatment, follow up of chronic cases and culling of older cows with repeated attacks, tick control as well as prompt treatment of teat/udder injuries are recommended to alleviate the condition.

Acknowledgements

This research was carried out by grant received from Animal Health Research Programme of Ethiopian Agricultural Research Organization (EARO). The cooperation and support by the owners of the smallholder dairy farms during data collection and examination of animals are highly acknowledged.

References


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PRODUCTION PERFORMANCE AND EXPLOITATION OF HETEROSIS IN CAMEROON INDIGENOUS (CF) AND GERMAN DAHLEM RED (GR) CHICKENS AND THEIR CROSSBREDS

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PERFORMANCE DE PRODUCTION ET EFFETS DE L'HETEROSES CHEZ LES POULETS LOCAUX CAMEROUNAIS ET LES POULETS ALLEMANDS DAHLEM ET LEURS CROISEMENTS

Résumé

Un essai de croisement de poulets locaux camerounais (CF) x poulets allemands Dahlem (GR) a été effectué, afin de déterminer la performance de production et d'évaluer les effets de l'hétérosis sur le gain de poids vif des coquelets et des poules pondues à divers âges, et de définir les paramètres de production d'œufs chez les pondues. On a eu recours à quatre groupes génétiques, à savoir : croisement GR x CF et CF x GR ; race pure CF x CF et GR x GR. Les coquelets issus du croisement CF x GR avaient le meilleur poids vif (P<0,05) à 12 semaines d'âge (1 036,17 ± 39,49g) comparé aux autres groupes génétiques. Les sujets issus de race pure GR x GR et des deux types de croisement ont pondu beaucoup plus d'œufs (P<0,05) que ceux issus de race pure CF x CF. Les poids des œufs était plus élevé chez les sujets de race pure (P<0,05) par rapport à celui des autres groupes génétiques. L'efficacité alimentaire pour la production d'œufs était meilleure (P<0,05) chez les sujets race pure GR x GR et les croisements que chez les sujets race pure CF x CF.

Les croisements GR x CF donnaient des valeurs positives d'hétérosis (h²) pour les poids vifs des poulets à 4, 6, 8, 10 et 12 semaines avec respectivement h² = 18,2 ; 17,1 ; 13,7 ; 16,7 et 20,8%. Pour les paramètres de production d'œufs, les croisements GR x CF donnaient des valeurs positives d'hétérosis (h²) de 16,4 ; 9,4 et 11,1% respectivement pour le nombre total d'œufs pondus, le poids total d'œufs et l'efficacité alimentaire. Ces résultats permettent de conclure que les poulets CF et GR peuvent être croisés pour tirer un maximum de profit des avantages liés aux effets de l'hétérosis et aux paramètres de production d'œufs.

Mots-clés : Croisement, Cameroun, allemand, poulets, performance, hétérosis.

Summary

A crossbreeding experiment using Cameroon indigenous (CF) and German Dahlem Red (GR) chickens was undertaken to determine production performance and heterosis estimates of body weight of cockerels and laying hens at various ages and egg production traits in layers. Four genetic groups were involved, namely: GR x CF crossbreds, CF x GR crossbreds, CF x CF purebreds and GR x GR purebreds.

Cockerels of the CF x GR crossbreds exhibited the heaviest (P<0.05) 12-week body weight (1036.17±39.49g) than the other genetic groups. The GR x GR purebreds and the crossbreds laid many eggs (P<0.05) than the CF x CF purebreds. Eggs from GR x GR purebreds were heavier (P<0.05) than those from other genetic groups. The feed efficiency for egg production was better (P<0.05) for the GR x GR purebreds and crossbreds than in CF x CF purebreds.

Positive heterosis values were realized in crossing GR and CF for 4-week, 6-week, 8-week, 10-week and 12-week body weight (16.2, 17.1, 13.7, 16.7 and 20.8% respectively). High positive heterosis values for egg production traits such as number of egg lay, egg mass and feed efficiency for egg production (16.4, 9.4 and 11.1%, respectively) were also observed in crossing GR and CF. It was therefore concluded that CF and GR fowls can be crossed to take maximum advantages of heterosis in growth and egg production traits.

Key-words: Crossbreeding, Cameroon, German, chickens, performance, heterosis.
Introduction

The population of indigenous (local) chickens in Cameroon is about 19 million, which accounts for about 70% of the total chicken population\(^1\). Though numerically local chickens substantially contribute to meat and egg supply, their productivity remains low\(^2\).

Growth and egg traits in chicken production are important since heavier marketable body weight and increased egg number contribute largely to the viability of chicken enterprises. Improvement for body weight and egg production of local fowl in the topics through selection has been attempted, resulting in considerable slow and little progress. In Nigeria improvement in 12-week body weight in local fowl by 297 grams after seven years of selection was recorded\(^3\). Because of inadequate infrastructures and limited funding, which is common in developing economy such as Cameroon, crossing of breeds to achieve faster growth and higher egg yield in chickens could be envisaged.

Crossbreeding increases heterozygosity in non-additive genes that causes heterosis. The heterozygosity is as a result of dominance, which is brought about by genetic interaction within loci, or epistasis, which is an interaction between loci\(^4\). Heterosis or hybrid vigour is a phenomenon in which the progeny of crosses between inbred lines or purebred population have better performance than the average of the parental populations. Heterosis is important in extreme environmental conditions, given rise to greater viability in chickens\(^5\). To maximise the performance of a population, mating should be designed to capitalise on all forms of heterosis as well as to exploit any sex-linked or maternal effects associated with particular combination of lines or breeds.

This study was undertaken to determine heterosis rates in body weight of cockerels and laying hens at different ages and egg production traits in a crossbreeding scheme that was intended to improve production performance of Cameroon indigenous chickens.

Materials and Methods

Origin of test birds and management

The trial was carried out at the Institute of Agricultural Reasearch for Development (IRAD, Mankon-Cameroon) farm. The experimental birds were generated from exotic improved German Dahlem Red breed (GR) and indigenous Cameroon chickens (CF). The GR was a high yielding dual purpose (meat and egg production), medium size and brown egg layer line. The GR parent stocks were imported from Germany (Humboldt University of Berlin). On the other hand, CF parent stock birds originated from eggs collected in several villages in the Western Highlands of Cameroon (North West and West Provinces) and incubated and hatched at IRAD, Mankon farm. These eggs were of small size and had a creamy shell colour, characteristic of local chickens.

To establish the experimental flock hens were artificially inseminated (AI) at 30 weeks of age with whole semen collected from cocks (indigenous and exotic), using a massage technique twice a week\(^6\). The mating plan, genetic structure and test population used are given in Table 1. After AI, eggs laid by hens were collected, marked for identification and stored at a room temperature ranging from 20\(^0\)C to 23\(^0\)C for two weeks prior to incubation for 21 to 22 days in a forced draft incubator/hatcher. Hatched chicks were wing-banded for identification and vaccinated against Newcastle, Infectious Bronchitis, Gumboro, Fowl pox and Fowl typhoid
**Table 1.** Mating plan, genetic structure and tested population

<table>
<thead>
<tr>
<th>No.</th>
<th>Parent genetic group</th>
<th>Offspring test population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>1.</td>
<td>GR x CF</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>CF x GR</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>CF x CF</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>GR x GR</td>
<td></td>
</tr>
</tbody>
</table>

1: GR x CF = German Dahlem Red mating with Cameroon Indigenous crossbred; CF x GR = Cameroon Indigenous mated with German Dahlem Red crossbred; CF x CF = Cameroon Indigenous purebred; GR x GR = German Dahlem Red purebred.

**Table 2.** Means and standard error of body weights of cockerels having different genetic composition.

<table>
<thead>
<tr>
<th>Genetic Group</th>
<th>Hatch Body Weight (g)</th>
<th>4-week Body Weight (g)</th>
<th>6-week Body Weight (g)</th>
<th>8-week Body Weight (g)</th>
<th>10-week Body Weight (g)</th>
<th>12-week Body Weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GR x CF</td>
<td>31.23± 0.35</td>
<td>165.72± 40.5</td>
<td>285.75± 6.5</td>
<td>424.15± 7.8</td>
<td>583.70± 11.54</td>
<td>817.16± 15.36</td>
</tr>
<tr>
<td>CF x GR</td>
<td>39.80± 0.91</td>
<td>194.24± 10.5</td>
<td>359.97± 16.57</td>
<td>539.0± 19.6</td>
<td>740.75± 31.04</td>
<td>1036.17± 39.47</td>
</tr>
<tr>
<td>CF x CF</td>
<td>29.94± 0.40</td>
<td>156.6± 4.54</td>
<td>276.57± 7.25</td>
<td>405.63± 8.93</td>
<td>542.12± 13.38</td>
<td>746.5± 17.42</td>
</tr>
<tr>
<td>GR x GR</td>
<td>41.29± 0.77</td>
<td>147.73± 8.58</td>
<td>274.29± 13.53</td>
<td>440.8± 17.43</td>
<td>592.34± 25.68</td>
<td>787.7± 33.36</td>
</tr>
</tbody>
</table>

* Different superscript within a column denote significant difference (P<0.05).
1-Genetic group name (see legend in Table 1).

**Table 3.** Means and standard error of body weights of laying hens having different genetic composition.

<table>
<thead>
<tr>
<th>Genetic Group</th>
<th>20-week Body Weight (g)</th>
<th>30-week Body Weight (g)</th>
<th>36-week Body Weight (g)</th>
<th>72-week Body Weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GR x CF</td>
<td>1389.7± 33</td>
<td>1691.9± 32.0</td>
<td>1695.0± 33.6</td>
<td>1704.4± 36.7</td>
</tr>
<tr>
<td>CF x GR</td>
<td>1577.7± 68.9</td>
<td>1775.9± 65.8</td>
<td>1885.6± 73.0</td>
<td>1958.7± 80.0</td>
</tr>
<tr>
<td>CF x CF</td>
<td>1333.8± 31.1</td>
<td>1600.1± 30.4</td>
<td>1634.0± 32.0</td>
<td>1760.0± 31.8</td>
</tr>
<tr>
<td>GR x GR</td>
<td>1462.0± 28.4</td>
<td>1971.7± 36.0</td>
<td>2127.6± 28.2</td>
<td>2359.9± 30.2</td>
</tr>
</tbody>
</table>

* Different superscript within a column denote significant difference (P<0.05).
1-Genetic group name (see legend in Table 1).
during the growing period.

Cockerels were subjected to growth test, which involved body weight gain from hatch to 12 weeks of age. At 19 weeks of age, the pullets were housed in individual battery cages (45cm x 50cm in size) for the laying test, which lasted 52 weeks (72 weeks of hen's age). During the laying test, data were collected daily on egg production, egg weight and feed intake. Data on body weight of individual hens at 20, 30, 36 and 72 weeks of age were also recorded.

Statistical analysis

Data on production performance was analysed using the general linear model of SAS programme package for statistical significant (P≤0.05)⁷,⁸.

Results

Performance

Table 2 shows that maximum hatch weight of cockerel was exhibited by the GR x GR purebreds group (41.29± 0.77g) and the lowest by the CF x CF purebreds group (29.94±0.40g). Among the crossbreds, heavier hatch weight (P<0.05) was 39.80±0.91g for CF x GR crossbreds as compared with 31.23±0.35g for the GRxCF crossbreds. From 4-weeks of age through 12-week, cockerels from CFxGR parents exhibited the heaviest (P<0.05) body weight than other genetic groups, which showed similarity in body weight. Chicks from CF dams (29.94±0.40g) were lighter (P<0.05) at hatch than their counterpart from GR dams (41.29±0.77g).

Estimation of heterosis

Heterosis was estimated as deviation of crossbreds performance from the average of the parental breeds using the following formula:

Heterosis(%) = Average of reciprocal crossbreds F1 offspring - Average of Parent lines x Average of Parents lines

*Parent lines in the experimental population are represented by purebreds F1 progeny.

Table 4. Means and standard error of egg production traits after 52 weeks of lay by hens having different genetic composition.

<table>
<thead>
<tr>
<th>Genetic Group¹</th>
<th>Sexual Maturity day</th>
<th>Egg laid (No.)</th>
<th>Egg Weight (g)</th>
<th>Egg mass (e.m.) (Kg)</th>
<th>(Kg e.m/Kg feed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GR x CF</td>
<td>168.7 ± 1.5⁴</td>
<td>208.3 ± 5.0*</td>
<td>52.7 ± 33.6⁵</td>
<td>10.9 ± 0.2*</td>
<td>0.25 ± 0.006*</td>
</tr>
<tr>
<td>CF x GR</td>
<td>165.7 ± 3.7*</td>
<td>223.7 ± 12.0*</td>
<td>50.0 ± 1.3³</td>
<td>11.2 ± 0.6⁶</td>
<td>0.25 ± 0.01*</td>
</tr>
<tr>
<td>CF x CF</td>
<td>173.7 ± 1.4⁴</td>
<td>157.9 ± 5.0*</td>
<td>47.7 ± 0.5⁴</td>
<td>7.4 ± 0.3⁴</td>
<td>0.18 ± 0.006⁴</td>
</tr>
<tr>
<td>GR x GR</td>
<td>179.3 ± 2.0*</td>
<td>213.7 ± 7.0*</td>
<td>60.4 ± 0.7⁴</td>
<td>12.8 ± 0.3*</td>
<td>0.27 ± 0.008*</td>
</tr>
</tbody>
</table>

⁴,⁵,⁶ Different superscript within a column denote significant difference (P<0.05).

* Feed efficiency = Kilogram of egg mass produced per kilogram of feed consumed.

¹-Genetic group name (see legend in Table 1).
The body weights at 20, 30, 36 and 72 weeks of age for pullets subjected to the laying test for the different genetic groups are shown in Table 3. The 20-week body weights among the purebred pullets were no different (P<0.05), comparatively (CFxCF, 1333.8± 31g and GRxGR, 1462± 28.4g). However, the GRxGR purebreds had significantly heavier (P<0.05) 72-week body weights (2359.9±30.2g) than its CFxCf purebreds counterpart (1760.0± 31.8g). Among crossbreds, body weight at 20 weeks of age were higher (P<0.05) for CFxGR (1577.7± 68.6g) than GRxCF (1389.7± 33g). Superiority was sustained throughout till the 72 weeks of pullets’ age.

Performance on egg production traits are given in Table 4. Crossbreds of CFxGR matured earlier (P<0.05) at 165.7± 3.7 days than purebred GRxGR (179.3± 2.0 days). However, there was no difference (P>0.05) amongst either purebreds or crossbreds for age at sexual maturity. Egg production was lowest (P<0.05) for the purebred CFxCF than either other genotypic groups. This same pattern was observed for egg mass and feed efficiency values. The GRxGR purebreds need the heaviest (P<0.05) egg weight than other genotypic groups (Table 4).

### Heterosis

Heterosis percentages for body weight and egg production traits are given in Table 5. Favourable positive heterosis was observed for 4, 6, 8, 10 and 12-weeks body weights for cockerels (18.2, 17.1, 13.7, 16.7, and 20.8%, respectively) in the German Dahlem Red and Cameroon fowl crosses. In laying hens, heterosis for body weights at 30-week, 36-week and 72-week of age were negative. Heterosis for body weight in layers was only positive at 20-week of age (6.3%).

Positive heterosis for egg production traits such as number of egg lay, egg mass and feed efficiency were observed (16.4, 9.4,
and 11.1% respectively). Negative heterosis was observed for the age at sexual maturity (-5.2%), egg weight (-4.2%), and 72-week body weight (-10.9%).

Discussion

Performance

Cameroon indigenous fowl (cockerels) attained a live body weight of about 747g at 12 weeks, higher the 530grams reported in Nigeria. Body weight at 12 week for cockerels from a cross of CFxGR was higher than pure CFxCFC (local) cockerels by about 172g (22%). This observation is similar to those reported by others, but lower than the 64% reported for 12 week body weight in crossbred cockerels. However, for the later, this higher improvement level was obtained through breeding and selection for over seven generations. The crossbreds in this study did not only get superior 12-week body weight over the local purebreds but were also superior to the German Dahlem Red chickens. This observation was similar to results earlier reported when local chickens were crossed with Gold-link chickens. Such superiority of crossbreds over purebreds may be due to the effect of non-additive genes such as over dominance.

The GR x GR purebreds had the highest 72-week-body weight compared with the other genetic groups. But comparison within the crossbreds indicated that CF x GR exhibited higher body weights than the GR x CF throughout the laying cycle. This finding is in agreement with the concept that maternal (genes on W-chromosome) effect is responsible for body weight gain.

Results on egg production traits pointed out that CF could serve as an important source of livelihood for poor rural farmers. The observed egg production of 158 eggs per annum was similar to those reported for local chickens in Nigeria and Indonesia, though lower egg production levels have been reported.

The egg weight of 47.7g exhibited by the Cameroon local chickens was similar to the results reported earlier for local fowls in Indonesia and Thailand. However, the eggs laid by local fowls in this study weighed about 26% less than those of German Dahlem Red fowls.

Heterosis

A higher positive heterosis was observed for 12-week body weight for cockerels (20.8%) in this trial than those reported in the local and Gold-link cross (9.5%) in Nigeria. The high heterotic obtained in this study could be attributed to the greater genetic distance between the tested breeds. The favourable positive (6.3%) heterosis observed in this study for 20-week body weight for pullets is in agreement the earlier findings by other scientists. The high positive heterosis of 16% recorded in this study for egg number was higher than results reported when local fowls were crossed with medium-heavy improved layer by some workers. However, the present results are on the lower side of those reported by others. Heterosis for egg weight was found to be negative (-4.9%), this result is contrary to those reported by earlier workers. Negative heterosis for egg weight had been reported ranging from -3 to -5% by others scientists. The positive heterosis for egg mass (9.4%) obtained in this study was within the range recorded earlier in a review.

Conclusion

It can be concluded that Cameroon indigenous fowl and German Dahlem Red
fowl can be crossbred to exploit non-additive genetic variance for growth and some egg production traits since the crossbreds yielded positive heterotic response. To take advantage of reciprocal effects, Cameroon indigenous cocks and German Dahlem Red hens can be used in a conventional cross-breeding scheme in Cameroon.

Acknowledgement

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References


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PREVALENCE OF ANTIBODIES TO THREE AVIAN VIRAL DISEASES IN GUINEA FOWLS IN IBADAN, NIGERIA.

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The grey-breasted helmet guinea fowl (\textit{Numida meleagris galeata} Pallas) occurs naturally in the savannah grasslands of West Africa and has been a traditional source of eggs and meat. It is the second most important poultry in Nigeria after chickens\textsuperscript{1}. Guinea fowls are concentrated in the arid Northern part of the country with few thousands in the humid South. The southwest is the main port of entry of imported chicken and the home of major poultry breeders that distribute day-old chicks and feed throughout the country and beyond\textsuperscript{2}. There has been increasing interest in the improvement of guinea fowl to boost supplies of poultry meat and eggs. This has necessitated studies into their disease problems.

Natural infections with avian paramyxovirus-1 (APMV-1), infectious bursal disease (IBD) virus and egg-drop syndrome '76 (EDS '76) virus have been reported in chickens and they are a major threat to the poultry industry worldwide. Serological evidence of APMV-1 and EDS '76 infections respectively had earlier been reported in guinea fowls in Nigeria\textsuperscript{3,4}. There are conflicting reports on the susceptibility of guinea fowls to IBD virus infection and this makes their role in the epidemiology of the disease unclear. Some workers\textsuperscript{5,6,7,8} could not detect IBDV antibodies in guinea fowl sera by the agar gel precipitation test (AGPT) while others\textsuperscript{9,10} reported a prevalence of 44.3% and 9.1% for IBDV antibodies respectively in guinea fowls by the same technique.

Since these surveys were done over a decade ago and with the increasing importance of guinea fowls as a potential base for boosting animal protein supplies as evidenced by previous studies on their productivity\textsuperscript{11,12,13,14}, the current status of these diseases needs to be ascertained to determine their impact on the trend of guinea fowl production in Nigeria. The present study aims at achieving this purpose.

This study focused on Ibadan in Oyo State, which has the highest commercial poultry activity in Nigeria with influx of birds from most parts of the country. Oyo State is located in the southwest of Nigeria (sharing borders with Ogun and Osun States of Nigeria and the Republic of Benin). It has a long, wet season and short, dry season (November-February). Two major markets, known for the sale and slaughter of guinea fowls, were chosen for the study. Owners objected to the sample collection as their guinea fowls were few per household and they were found in the neighboring bush. They were also very difficult to catch, hence the choice of the sale/slaughter point for sample collection.

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Adult, apparently healthy guinea fowls brought for sale from different owners in surrounding villages of Ibadan were used in this study. Blood was collected into plain Universal bottles from every fifth bird slaughtered. The clotted blood was kept at 4°C overnight. Separated sera were inactivated at 56°C for 30 minutes and stored at −20°C until tested.

The sample size for the EDS 76 study was smaller because the sera tested were from female birds only. The number of flocks involved and the number taken per flock could not be determined. The guinea fowls used in this study were greater than one year of age and were reared extensively. They normally scavenge for food in neighboring bushes during the day and after dusk, they settle on nearby trees. All the birds had no history of vaccination against the three diseases.

The haemagglutination inhibition (HI) technique was used to assay sera for EDSV and APMV-1 antibodies as previously described. Briefly, serial two-fold dilutions of sera were prepared in microtitre plates. Each dilution of serum was then reacted with 4 haemagglutinating units of the viral antigen at 25°C for 30 minutes. 1% chicken red blood cell (RBC) suspension in normal saline was added to each well as an indicator. Virus and RBC controls were set up in separate wells and results were read in 45 minutes. Presence of neat, round pellets of red cells was interpreted as a positive result. Agar gel precipitation test (AGPT) was carried out as already described to detect IBDV precipitins in the sera. The Chi-square test was used to assess differences in prevalence of antibodies to the three diseases. For the analysis, a value of P<0.05 was considered significant.

Of the 72 sera tested for EDSV antibodies, only 20 (27.8%) were positive with titres ranging from 1:2 to 1:64, while 22 (12.2%) out of the 180 sera assayed for APMV-1 antibodies were positive with titres ranging from 1:2 to 1:32. All the 180 sera tested for IBDV precipitins were negative even when the positive controls gave precipitin lines within 36 hours and the negative controls were negative.

The results of serology indicate that the guinea fowls used for this study were exposed to APMV-1 and EDS 76 viruses. Since the guinea fowl population in Nigeria is known to arise from wild or semi-wild sources where routine vaccination against these diseases is not practiced, it could be inferred that antibodies detected in this study were as a result of natural infection of the guinea fowls by these viruses. The source of the virus could be infected chickens since both chickens and guinea fowls are sometimes reared together under the extensive system.

EDS antibody prevalence rates of 100% and 69.8% respectively had been reported in guinea fowls. In addition, APMV-1 antibody prevalence of 65.2% was reported. Compared with the 27.8% and 12.2% prevalence rates recorded for EDS and APMV-1 respectively in this study, it is apparent that there is a considerable decline in EDSV and APMV-1 activity in guinea fowls in Nigeria. Improvement in the vaccination programmes against these diseases due to increased awareness among both commercial and backyard poultry farmers leading to a reduction in the rate of transmission of these diseases between domestic and wild birds could be a possible reason for this observed decline.

The non-detection of IBDV antibodies in guinea fowls in this study is in conformity with earlier reports. However,
experimentally infected guinea fowls have been reported to show typical clinico-pathological features and seroconversion for IBD\(^9\), suggesting that they could play an active role in the epidemiology of IBD while a 9.1% IBD antibody prevalence was reported in guinea fowls in the Northeastern part of Nigeria\(^10\). These contradictory reports may be attributed to the sample size analyzed by the various workers. Additional studies are still being done to further characterize natural and experimental IBD in guinea fowls to ascertain their true status in the epidemiology of IBD in Nigeria.

These results give an indication of the current status of these three major diseases of guinea fowls in Nigeria. Efforts towards their eradication from the Nigeria poultry population should therefore include adequate surveillance and control of these and other health-related problems of guinea fowls.

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EDS antibody prevalence rates of 0.27 have been reported. The rate of EDS subtypes and cases has been derived from data gathered at the EDS study. Comparison with the previous 12.25 prevalence rate suggests a possible reason for the observed decrease.

The non-selection of Bovine leukemia virus (BLV) cases in this study is in contrast with rarer reports. However,

Of the 72 cases studied, 45 were

Acknowledgments:

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SHORT COMMUNICATION

THE IMPACT OF CULTURE AGITATION AND STARTING pH OF GROWTH MEDIA ON THE MYCOPLASMAL YIELD OF MYCOPLASMA CAPRICOLUM SUB.SP CAPRIPNEUMONIAE

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Contagious caprine pleuropneumonia (CCPP) is an economically important infectious disease of goats caused by Mycoplasma capricolum sub SP capripneumoniae (Mccp) with high morbidity and mortality rates, both which approximate to 100%\(^1\). Contagious caprine pleuropneumonia is one of the major constraints to goat production posing serious economic losses in Africa and Asia. In Ethiopia it has been confirmed to be endemic and is more prevalent in the arid and semi-arid lowlands where about 75% of the national goat population are reared. Goats constitute one of the important live animal export commodities of Ethiopia especially to the Middle East countries. However, due to the presence and wide spread nature of diseases like CCPP, currently, international trade ban has been imposed on Ethiopian livestock and livestock products.

National Veterinary Institute is currently manufacturing inactivated liquid vaccine from F-38 strain but the current vaccine supply is found to be far below the requirements of the country. The laboratory is producing 50,000 doses CCPP vaccine per year while the national demand is over 13 million doses, as the disease is prevalent in all goat-rearing areas. At National Veterinary Institute cultural conditions have not been optimised; they were rather based on the empirical extrapolations.

This piece of work was, therefore, intended to investigate the impact of starting pH of culture media and agitation on the mycoplasmal yield of F-38.

The seed strain considered was Mccp (F-38) vaccine strain, which is currently used at National Veterinary Institute for vaccine production. Hayflick medium (used for inoculum preparation) and Medium F-66 of Farcha laboratory (production medium) were used. Hayflick medium was formulated and dispensed in two culture vessels. The pH of the medium in one of the vessels was adjusted to 8.0 units while the pH of the remaining one was adjusted to 7.6. Similarly medium F-66 were prepared in two culture vessels. The pH of one them was adjusted at 8.0 while the other was adjusted at 7.6. Observation on the impact of agitation was made using both media in which one of the cultures was incubated stationary while the other one was agitated.

The final mycoplasmal yield was harvested between 72 and 168 hours post inoculation at an interval of 10 hours in both cases. The mycoplasmal content was determined by using Spearman-Karber techniques. The mean mycoplasmal content of the culture whose initial pH was 8.0 was

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found to be $8.3 \log_{10}^{CCU}$ (color changing units) while the mean yield was found to be $5.5 \log_{10}^{CCU}$ for cultures with 7.6 starting pH units. This peak growth was obtained between 96 hours and 144 hours of incubation. This finding clearly showed that cultures with higher initial pH units gave 3 more $\log_{10}^{CCU}$ of mycoplasmal (F-38) yield than those cultures with lower pH units.

Literature on the biology of mycoplasmal organisms revealed that these organisms could grow best between 7.0 and 8.0 pH units. F-38 strain, like other mycoplasmas of the mycoides cluster, is fermentative organism: it breaks down carbohydrates in the growth media to organic acids, which accounts for a drop in pH. Continuation of culture further reduces the pH and eventually becomes fatal to the mycoplasmas. The limiting pH value of the culture for mycoplasmas below which growth could not be sustained was found to be 6.7 units. When the initial pH of the growth media is adjusted to 7.6 the organisms produce fewer generations before the pH falls to the limiting value. But when the pH is adjusted to higher units (e.g 8.0) the mycoplasmas can undergo more multiplication and tend to yield more number of generations before the pH drops to 6.7 or lower.

Since the mycoplasmal yield of the production media is dependent on the richness of the inoculum, and the final antigen yield of the bulk production suspension is a reflection of the total mycoplasmal content of the culture, higher initial pH units of growth media has significant impact on the final F-38 antigen yield. Different workers have obtained similar results in similar mycoplasmas of the mycoides cluster. Maximal antigen (mycoplasmal) yield was obtained for instance when the starting pH of the production media of Mycoplasma mycoides sub SP mycoides SC (bovine biotype) vaccine strain was adjusted to 8.1 and 7.8 - 8.0 than when adjusted to 7.6$^{35}$.

Mccp organisms grown in stationary cultures were found to give more viable mycoplasmas than agitated cultures. Moreover, there was clear sediment formation in stationary cultures while no evidence of sedimentation was recognized in agitated cultures. Phases growth of F-38 is monitored by sediment formation and the degree of sedimentation is an indication of the stage of growth of the organisms. Slight whitish sediment is formed at the bottom of culture vessels when the organisms are at their exponential growth phase, which is considered the best stage for harvesting of cultures for preparation of seed stocks or sub-culturing. Heavy sediments deposit at the bottom of culture vessels during the declining phase of growth; harvesting for antigen preparation is performed at this stage.

The impact of culture agitation on Mccp (F-38) could be explained that continual aeration in agitated cultures causes oxidation of glycerol in growth medium and forms peroxides. The peroxides can accumulate in the culture to the toxic concentration and reduces the viability and growth rate of these organisms. Besides, agitation disturbs the cultures and the organisms fail to sediment. This causes growth monitoring very difficult. However, agitation can increase the rate of growth of fast multiplying mycoplasmas such as Mycoplasma mycoides sub SP mycoides SC (bovine biotype), which can utilize the glycerol before the sufficient peroxides could be produced. Agitated cultures withstand the adverse effects of downstream processing like lyophilization. Owing to this fact the loss of viable bacterial titre after lyophilization is minimal compared to stationary cultures.

In conclusion, higher initial pH values
of the growth media and stationary cultures will increase Mccp (F<sub>36</sub>) growth rate and the final antigen yield. Stationary cultures as well allow monitoring of the growth of these organisms. This increases the volume of vaccine production when used properly.

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Since the asymptomatic yield of the production media yields a very high yield of the bulk product, Acriflavine is a competitor of the total biomass production in the culture. Higher final pH values of the media have significant impact on the yield. Different media changes should result in a lower biomass yield than the starting culture. Major changes such as pH, pressure, and temperature can influence the yield. Mycoplasmas in cultures such as SP-Mycobacterium mt. abscessus (Spiney subtype), which are under the same conditions as the infected pericardial fluid, produce ingested colonies which can be advantageous. Even after a short incubation, the adverse effects of down-shock processing from contamination. Despite this, the loss of viable colonies like these, upon isolation in vitro, can be at least reasonably expected.

In conclusion, higher initial pH values
SHORT COMMUNICATION

AN OUTBREAK OF WHITE SPORT DISEASE (ICHTHYOPHTHIRIUS MULTIFILIIS) IN ORNAMENTAL FISH.

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Icthyophthiriosis, "white spot disease", "ich" or "itch" is a disease of freshwater fish caused by protozoan Ichthyophthirius multifiliis\(^1\). I. multifiliis is a holotrichous, histophagous ciliate possessing a large, crescent-, sausage-, or hosed-shaped macronucleus and at least one small round micronucleus\(^2\). I. multifiliis has a direct life cycle involving an obligate fish-associated trophont, a free living reproductive stage (tomont) and the infective stage of the parasite, termed the theront\(^2\). The parasite causes lesions in the skin and gills. The disease is characterised by typical signs of external parasitism with characteristic white spots on the skin and gills.

Icthyophthiriosis does not appear to have a predilection for any specific group of fish, although it is believed to have originated as a disease of carp\(^2\). The parasite appears to have been spread to its present range as a result of transportation of fish to various regions for aquaculture or as pets. In the Southern African region, Bragg\(^3\) found that the disease occurred in salmonids from South Africa rivers in areas where there is intensive aquaculture. No reports of the disease in Zimbabwe and other Southern Africa countries have been published as yet.

Six species of ornamental fish, namely, Cyprinus carpio (Koi carp), Carassius auratus (Goldfish), Xiphophorus maculatus (Platy), Xiphophorus helleri (Sword), Poecilia (Guppy) and an unidentified species of the Malawian chichilds from two separate households, were presented to the University of Zimbabwe Veterinary Teaching Hospital for post mortem examination. Some of the fish on the two households had been recently acquired from the same breeder. There was a history of high mortality (>90%) in both ponds, unrestricted to either a particular species nor age group. Dying fish exhibited diffusely distributed white spots on the skin surface.

An inspection of the ponds from the two households was carried out. In household A, approximately 1000 fish of mixed species were held in a pond of approximately 20,000 litres of water. Household B had approximately 600 fish of mixed species in approximately 20,000 litres of water. In both households, the water temperature was approximately 20°C, pH was 6.3 and water flow rate about 10,000 litres per hour. For both households, there was high pond vegetation biomass.

On clinical examination of live fish from both households, the fish had characteristic white spots ranging from 0.3 to 1 mm, and an increased amount of mucus on the body and fins. Most of the fish were lethargic and there was loss of appetite with evidence of respiratory distress (surface breath-
ing and rapid respiration). Some of the fish were seen rubbing themselves against the walls of the pond. Most of the large fish had focal or multifocal pale patches on the skin.

Parasitological examination involved the microscopic evaluation of unstained wet mount preparations of scrapings of skin and gills overlaying the white spot lesions of the affected fish. Microscopic examination at a x 40 magnification revealed widely varying sizes of a motile (rolling around), spherical, holotrichous ciliate with a “horsehoe-shaped” nucleus.

Necroscopic examination was performed on 25 fish which were found dead in the ponds and also on 10 sick fish which were euthanised. The majority of the fish showed few nodular (raised) white spots on the skin surface with only six specimens exhibiting diffuse spots. A few of the fish presented already dead had no discernable white spots on the skin surface. All the specimens had an abnormally conspicuous covering of skin surface mucus with some of the mucous sloughing off the skin. One of the fish, a Koi carp (*Cyprinus carpio*) had grossly visible haemorrhages on all the articulations of the fins. No gross lesions were identified in other organs.

On haematoxylin and eosin stained slides, there was hydopic degeneration and necrosis of the epithelial layers of the skin. In five cases, trophonts with horse shoe-shaped macronucleus were present within an epithelial capsule. There was evidence of haemorrhage occurring in the skin in four cases. In most cases, no trophonts on the skin could be identified. However, there was marked epithelial cell hyperplasia and a generalised increase in the number of mucous cells in the skin in these cases. There was infiltration by moderate number of neutrophils and a few lymphocytes. Examination of the gills showed hyperplasia of the epithelium with prominent mucous cells. There was infiltration by moderate number of neutrophils.

The histopathological demonstration of trophonts from the skin and gill scrapes on areas overlying the white spot lesions on fish exhibiting typical signs of ectoparasitism and the demonstration of varying sizes of a motile, spherical, holotrichous on wet mounts allowed us give the definitive diagnosis of ichthyophthiriosis. In some cases, death can occur without skin lesions when large numbers of theronts cause massive damage to the gill epithelium. In these cases, diagnosis will be based on parasitological examination of gill scrapes as well as histopathology of the gill lamellae. In our case, some of the fish had no discernable skin lesions except excessive mucus production and diagnosis of ichthyophthiriosis was reached using skin and gill samples. Absence of discernable skin lesions on some of the fish could have been due to massive gill epithelium damage leading to acute death, mild infection levels with the parasite and/or the fish being lightly pigmented as are the *Xiphophorus helleri*.

Fish exposed to *I. multifilis* develop protective immunity, therefore, survivors of an epizootic are resistant to subsequent infection. In native populations, young fish might be more susceptible to infection than older individuals in the latter were previously exposed to the parasite. Although all species of freshwater fish are susceptible to *I. multifilis*, the degree of susceptibility varies between different species, probably depending on factors such as the genetic background of the fishes. Environmental or physiological stress also increases susceptibility of fish to *I. multifilis*. In the present case, all the species were affected regardless of
breed, age or sex, and this could have been attributed to the population being naive (absence of previous infection).

*I. multifiliis* is usually introduced into fish populations by the addition of new fish. In our case, the origin of the infection seems to have been the breeder from which the fish were acquired as clinical cases were encountered in two households supplied by the same breeder. To avoid such outbreaks, preventive and control measures must be followed, that is; prevention of exposure of fishes to the parasite, prompt identification of the disease when it occurs, and treatment of infected fish. In this case, recommendations were made for the dilution and removal of the theronts in the water by evacuation and translocation of the remaining fish to a temporary aquarium for about a week and increasing water flow through the pond to break the cycle of infection. This was to be done concurrently with the treatment of the pond with potassium permanganate at four parts per million.

**References**

The objective of this study was to document the presence and distribution of skin lesions in fish captured in the wild. A total of 100 fish, representing different species, were examined for skin lesions. The examination revealed a high prevalence of skin lesions, with lesions ranging from superficial ulcers to deep abscesses. The most common lesions were found on the dorsal and ventral surfaces of the fish. No gender differences were observed in the prevalence of skin lesions.

On histological examination, the skin lesions were characterized by a dense infiltrate of inflammatory cells, including neutrophils and macrophages. The lesions were often associated with necrotic tissue and areas of epithelial hyperplasia. The presence of these lesions suggests a chronic inflammatory process. The severity of the lesions varied among species, with some species showing more pronounced lesions than others.

The results of this study indicate that skin lesions are a common occurrence in wild fish populations. The factors contributing to the development of these lesions are likely multifactorial and include environmental stressors, pathogen exposure, and host immune response. Further research is needed to elucidate the specific mechanisms underlying the development of skin lesions in wild fish.

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.

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Deux exemplaires des articles doivent être adressés à Monsieur le Rédacteur en Chef, Bulletin de la Santé et de la Production Animales en Afrique, Union Africaine/Bureau interafricain des Ressources animales, P.O. Box 30786, 00100 Nairobi, Kenya. E-mail: ibar.office@au-ibar.org


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.
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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.

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Remerciements éventuels.

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