GUIDANCE FOR AUTHORS

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

Submission of Articles
Two copies of articles should be sent to the Editor, African Union/Interanfrican Bureau for Animal Resources, P.O. Box 30786, 00100 Nairobi, Kenya. E-mail: ibar.office@au-ibar.org

Manuscripts should be in clear concise English or French, typewritten with double spacing and adequate margins. The spelling should be that of The Oxford English Dictionary or Le Petit Robert.

An article submitted for publication implies that its content has not been published elsewhere and that it is subject to editorial revision.

Types of Articles Published in the Bulletin
- Full papers providing accounts of original work.
- Short Communications.
- Review articles invited by the Editor.
- Editorial.
- Letters to the Editor.
- Book Reviews.
- News and announcements.

Format for Articles
The manuscripts should contain the following features:
Title, which should be concise, not more than 15 words long, followed by the author(s) name(s) and institutions to which work should be attributed and address for correspondence, if different.

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

Introduction stating the purpose of the work.

Materials and Methods used.

Results presented concisely.

Discussion of significance.

Acknowledgements.

References numbered consecutively in the order they are first mentioned in the text. Identification of references in the text should be by numbers (in parentheses) and not by authors' names.

References should take the following form:
1. Journals
Surname and initials of authors(s), year of publication (in parentheses). World List abbreviation of title of periodical (underlined), volume number (arabic numerals), first page number. The title of the articles should not be included.

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

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

If the same author is cited more than once, his publications should be arranged in chronological order in the list of references, and if more than one publication is included, the letters "a, b, c" should be added in both the list of references and in the text.

Illustrations
Tables should be limited and number of headings restricted. A massive table is difficult to read even if it can be reproduced. Tables and figures should be numbered consecutively. Table 1 etc., or Fig. 1 etc., respectively, and attached at the end of the text. References to tables and figures in the text should be by number and not to "table below" or "figure below". Coloured illustrations are reproduced only at the author(s) expense.

Short Communications
A Short Communication implies that the article does not justify publication as a conventional paper. Such communication should be restricted to two printed pages or 1,000 words including a maximum of two illustrations. It should therefore contain similar features as a regular paper but summary and separate subheadings are not necessary.

Proofs
One set of proofs will be sent to the author to be checked for printer's errors and should be returned within three days.

Offprints
25 offprints of each article will be supplied free of charge. Additional offprints may be ordered and paid for at the proof stage. Each extra offprint costs US $2.00.

Subscriptions
The annual subscription fee, including postage (surface mail) and handling is US $50.00. Air mail charges are available upon request.

Back Volumes
Back issues are also obtainable upon request at similar charges.
# ORIGINAL ARTICLES

<table>
<thead>
<tr>
<th></th>
<th>Title</th>
<th>Authors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Helminthiasis in free-ranging indigenous domestic poultry in Kenya.</td>
<td>B.A. OKECH, L.W. IRUNGU and J.E. COOPER</td>
<td>92</td>
</tr>
<tr>
<td>3</td>
<td>Verricular encephalitis associated with leukaemic lymphosarcoma in bovine calf.</td>
<td>A.N. MAINA, T.A. NGATIA, D.I. KARIOKI, P.K. GATHUMBI, T.A. ABUOM, P.N. GITONGA and V.J. CHEMIS</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>Livestock and their role in Mwea irrigation scheme agro ecosystem.</td>
<td>E.G. KIARIE, L.W. KABUJAGE, G.K. GITAU, J.W. WAKHUNGU and C.M. MUTERO.</td>
<td>110</td>
</tr>
<tr>
<td>5</td>
<td>The use of bovine colostrum as a source of immunoglobulin (Ig) for lambs</td>
<td>R.L. GLOVER, E.K. AWOTWI, B. AWUMBILA and K. OPPONG-ANANE.</td>
<td>118</td>
</tr>
<tr>
<td>7</td>
<td>Experimental trials with V₄HR and LaSota Newcastle disease virus vaccines administered to chicks via eye drop, drinking water and commercial feed.</td>
<td>J.A. NWANTA, J.U. UMHO, P.A. ABDU and I. AJOGI</td>
<td>132</td>
</tr>
</tbody>
</table>

# SHORT COMMUNICATIONS

<table>
<thead>
<tr>
<th></th>
<th>Title</th>
<th>Authors</th>
<th>Page</th>
</tr>
</thead>
</table>
ORIGINAL ARTICLES

1. Extension of laboratory facilities for the detection of psittacosis in South Africa. N. L. SEEMANN

2. Observations on the geographical occurrence of the mouse pest in South Africa. E. H. ROBERTSON

3. The use of the mouse in the control of the human louse in South Africa. F. A. NOYES

SHORT COMMUNICATIONS

1. Notes on some of the foodstuffs consumed in South Africa. F. A. NOYES

2. The control of the tsetse fly in the Northern Transvaal. W. H. MILLER

3. The control of gambier in South Africa. J. A. SMITH
EVALUATION OF ALTERNATIVE HEALTH INTERVENTIONS AGAINST SARCOPTIC MANGE AND GASTRO-INTESTINAL NEMATODES IN SMALLHOLDER PIG HERDS IN KENYA

J.K. WABACHA**, J.M. MARIBE¹, C.M. MULEI¹, M.N. KYULE², K. H. ZESSIN², W. OLUOCH-KOSURA³

¹Department of Clinical Studies, Faculty of Veterinary Medicine, University of Nairobi, P.O. Box 29053, Nairobi, Kenya
²Postgraduate Studies in International Animal Health, Faculty of Veterinary Medicine, Freie Universität Berlin, Luisenstrasse 56, D- 10117, Berlin, Germany
³Department of Agricultural Economics, Faculty of Agriculture, University of Nairobi, P.O. Box 29053, Nairobi, Kenya

EVALUATION DES AUTRES MESURES SANITAIRES CONTRE LA GALE SARCOPTIQUE ET LES NEMATODES GASTRO-INTESTINAUX DANS LES PETITES EXPLOITATIONS PORCINES AU KENYA

Résumé
On a mené une étude pour évaluer les autres mesures sanitaires pour le contrôle de la gale sarcoptique et des nématodes gastro-intestinaux dans les petites exploitations porcines dans la Division de Kikuyu, District de Kiambu, au Kenya. Au total, 40 troupeaux étaient répartis au hasard, à l’aide d’une simple méthode randomisée, en 3 groupes sous-traitement et 1 groupe-témoin. Chaque groupe était composé de 10 troupeaux. Les troupeaux du groupe 1 (groupe-témoin) étaient traités avec un placebo (à l’eau physiologique). Dans le groupe 2, on a utilisé l’ivermectine ; tandis que dans le groupe 3, on a eu recours à l’hydrochlorure de pipérazine et à un acaricide (amitraz) respectivement. Dans le groupe 4, l’hydrochlorure de levamisole et l’amitraz étaient utilisés respectivement. L’action anthelmintique de l’ivermectine n’était pas différente (p>0,05) de celle du levamisole. La proportion de porcs positifs pour les acarases était la même (p>0,05) chez les groupes traités à l’ivermectine et à l’amitraz. Le coût total des traitements/porc s’élevait à 0,50 $ EU pour l’ivermectine ; 0,31 $ EU pour l’association pipérazine/amitraz et 0,26 $ EU pour l’association levamisole/amitraz. L’association médicamenteuse amitraz/levamisole était la plus efficace et la plus économique contre la gale sarcoptique et les nématodes gastro-intestinaux des porcs dans les petites exploitations, qui ont fait l’objet d’études.

Summary
A study to evaluate alternative health interventions for the control of sarcoptic mange and gastro-intestinal nematodes in smallholder pig herds was carried out in Kikuyu Division of Kiambu District, Kenya between August and December 2000. A total of 40 herds were randomly allocated, by a simple random strategy, to 3 treatment groups and 1 control group. Each group comprised of 10 herds. Herds in group 1 (control) were treated with a placebo, physiological saline. In group 2, ivermectin was used, while in group 3, Piperazine hydrochloride and an acaricide (amitraz) were used, respectively. In group 4, levamisole hydrochloride and amitraz, were used respectively. The anthelmintic activity of ivermectin was not different (p>0.05) from that of levamisole. The proportion of pigs positive for mites was not different (p>0.05) between the ivermectin and the amitraz treatment groups. The overall costs per pig for the treatments were US$0.50 for the ivermectin treatment, US$0.31 for the piperazine/amitraz combination treatment and US$0.26 for the levamisole/amitraz combination treatment. Amitraz/levamisole drug combination was the most cost-effective against sarcoptic mange and gastro-intestinal nematodes of pigs in the studied smallholder herds.

*Corresponding author email: jwabacha@yahoo.com
Introduction

Sarcoptic mange (caused by Sarcoptes scabiei) and gastrointestinal helminthosis are highly prevalent and cosmopolitan diseases of pigs associated with significant economic losses due to both reduced growth rate and feed conversion efficiency\(^1\).\(^2\).

Sarcoptic mange and helminthosis can be controlled through improved management practices and strategic use of acaricides and anthelmintics, respectively\(^3\).\(^4\). In the smallholder herds of Kikuyu Division of Kiambu District, Kenya, the majority of farmers use piperazine hydrochloride and amitraz once every three months, as recommended by extension staff, to control nematodes and mange, respectively\(^5\). The farmers’ practices have not been evaluated against other control options that are available for the control of the diseases. This study was therefore carried out in the smallholder farms in Kikuyu Division of Kiambu District, Kenya, to compare the efficacy of various acaricides and anthelmintics in the control of sarcoptic mange and nematodes, respectively, for a period of three months.

Several modelling techniques are available to help perform economic analyses of animal disease control\(^4\).\(^5\).\(^6\). In this study, cost-effectiveness analysis was used to evaluate the health interventions. Technical data were compared with cost estimates for the various treatments to allow an assessment for the most cost-effective treatment for the two diseases.

Materials and methods

Study area and herds

The study was undertaken in a high potential peri-urban area in Kikuyu Division of Kiambu District, Kenya, in 40 herds between August and December 2000. The study area and the characteristics of the smallholder pig herds have been described previously\(^7\). In summary, the smallholder pig herds consisted of crossbreeds of Large White, Landrace and Hampshire breeds with a median of 9 pigs per herd. The pigs were confined in simple houses all the year round. The hygiene status in most of the herds was poor. Restricted feeding was practiced in all the herds with most farmers feeding their pigs on commercial feeds that were not specifically formulated for pigs.

Intervention design

This was a randomised, placebo-controlled intervention study. A total of 40 herds were randomly allocated, by a simple random strategy using a table of random numbers, to 3 treatment groups and 1 control group. Each group comprised of 10 herds. In the selected herds, piglets more than 4 weeks of age and grower pigs not more than 40kg in weight (approximately 4 months of age) were used. The experiments were designed as in Table 1.

Data and sample collection

Rectal faecal samples for faecal egg counts and ear wax scrapings for mite detection were taken before the treatment (Day 0) and at days, 7, 14, 28, 68, and 96 post-treatment. The faecal samples were analysed using a modified McMaster technique\(^7\). Eggs were identified as strongyles, strongyloids, ascarids and Trichuris suis eggs. The ear wax scrapings were taken by scraping the inner aspects of the ear until traces of blood could be seen. The material was examined under the light microscope for the presence of mites after digestion with 10% potassium hydroxide.

During the visits, the behaviour of the recruited piglets and grower pigs was observed.
for signs indicative of pruritis, such as rubbing against the walls and troughs, and scratching of the flanks or ears with the hind legs. In each herd the pigs were observed for 15 minutes and the scratching index (SI) was calculated as the number of scratching/rubbing episodes divided by the number of pigs observed. The SI was used to assess hypersensitivity to mite infestation in the group.8,9,10

Data analysis

Data analyses were performed using Minitab Statistical Software, Release 13 for Windows (Minitab Statistical Software, Minitab Inc., USA). Before the analysis, the faecal egg counts were transformed to their natural loga-

Table 1: Experimental design for the treatment of nematodes and sarcoptic mange in smallholder pigs in Kikuyu division, Kiambu district (August - December 2000).

<table>
<thead>
<tr>
<th>Experimental Group</th>
<th>Number of pigs</th>
<th>Intervention</th>
<th>Dose</th>
<th>Treatment for nematodes</th>
<th>Treatment for sarcoptic mange</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Control)</td>
<td>44 (29 growers + 15 piglets)</td>
<td>Physiological saline</td>
<td>0.5ml subcutaneously per pig</td>
<td>Placebo</td>
<td>Placebo</td>
</tr>
<tr>
<td>2</td>
<td>71 (32 growers + 39 piglets)</td>
<td>Ivermectin (Cavamec®, 1%, Sanofi, Hungary)</td>
<td>300μg/kg body weight subcutaneously Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>66 (44 growers + 12 piglets)</td>
<td>Piperazine hydrochloride (Piperazine®, Dopharma, Holland)</td>
<td>440mg/kg body weight orally Yes No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>80 (64 growers + 16 piglets)</td>
<td>Levamisole hydrochloride (Leva® 20, Agrar, Holland)</td>
<td>8mg/kg body weight, orally Yes No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Amitraz (Tactic®, 12.5% w/v, Hoechst, Germany)</td>
<td>0.1% as a spray twice at an interval of 7 days. The pens were sprayed as well No Yes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The results were obtained from the analysis of variance (ANOVA) comparing the experimental groups.
Table 2: Drug and labour inputs and respective costs in Kshs (parentheses) for the control of nematodes and sarcoptic mange in pigs in smallholder herds in Kikuyu Division, Kiambu District, (August 2000-December 2000).

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amitraz (Tactic®) (in millilitres)</td>
<td>-</td>
<td>520 (936)</td>
<td>580 (1044)</td>
</tr>
<tr>
<td>Piperazine DHC (in grams)</td>
<td>-</td>
<td>303 (509)</td>
<td>-</td>
</tr>
<tr>
<td>Levamisole (Leva® 20) (in grams)</td>
<td>-</td>
<td>-</td>
<td>137 (369)</td>
</tr>
<tr>
<td>Ivermectin (Cevamec® (in millilitres)</td>
<td>37 (1443)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Labour (hours)</td>
<td>2.8 (1420)</td>
<td>10.5 (197)</td>
<td>13 (247)</td>
</tr>
<tr>
<td>Labour (Man-days)</td>
<td>0.4</td>
<td>1.3</td>
<td>1.6</td>
</tr>
<tr>
<td>Average cost per pig</td>
<td>40</td>
<td>25</td>
<td>21</td>
</tr>
</tbody>
</table>

...rithms. Descriptive statistics for the scratching index, for the proportions of pigs positive for mites and for the faecal egg counts per gram of faeces (epg) for each treatment group and visit were carried out. The differences among the treatment groups by visit on the scratching index, on the proportion of pigs positive for mites and on faecal egg counts were determined, using the one way analysis of variance. Since the F-test and pairwise multiple comparison can sometime conflict (Minitab Inc., USA), pairwise comparisons for significant differences of the means (p<0.05) was not conditioned upon significance (p<0.05) of the F-test. Tukey's LSD (Least Significant Difference) was used for the post-hoc comparisons.

Economic analysis of the interventions

A relative cost-effectiveness analysis was used to determine how the desired result, the control of the two parasitic diseases, could be achieved at minimum cost. For this, the costs of the different treatment groups were computed and compared. The costs considered were those of labour and drugs.

The cost of family labour was included in all computations in order to reflect the real cost of each treatment and to allow a valid comparison across the different treatment groups. Family labour costs were calculated as opportunity costs. For hired labour, the prevailing wage paid to a casual labourer per day, equivalent to Kshs. 150 (US $1.9), was used. In the case of ivermectin treatment, where professional veterinary involvement was required, the appropriate professional fee of about KShs 20 (US $ 0.25) per pig was used to compute the labour costs. The time required to deworm and to control mange per litter was estimated and used to calculate the man-days for hired and for family labour. Man-days were multiplied with the prevailing wage rate per day to get the cost of labour. The opportunity cost for the time spent on the purchase of drugs was taken as zero, since the smallholder farmers do go to the market place for purchases and sales of their produce at least once a week; it was assumed that they could buy the drugs at the same time. The costs of drugs were calculated by multiplying the retail price of each drug with the amount used in the study.

Results

Voluntary participation rate

During the farm selection, the initial sample size was 40 herds; one farm selected had all the pigs sold in the morning of the intended first visit, this farm eventually was not replaced. Therefore, the initial voluntary
participation rate was 97.5% (39/40). In the course of the study, a total of six farms withdrew at different times; the reasons for the withdrawals included death of all the pigs in the herd (one farm), sale of all the pigs (4 farms) and one farmer withdrew for reasons related to the interventions. The voluntary participation rate throughout the study correspondingly reduced to 84.6% (33/39). Data collected from these farms until the date of withdrawals were included in the analysis.

**Helminth control**

The arithmetic mean faecal egg counts (FEC) from Day 0 to Day 96 are presented in Figure 1. The pre-treatment mean faecal egg counts (FEC) for the four groups did not differ significantly (p>0.05). On day 7 post-treatment the FEC for the ivermectin-treated group was significantly (p<0.05) lower than for the piperazine-treated group. Both ivermectin- and levamisole-treated groups had significantly (p<0.05) lower FEC on day 14 post-treatment as compared to the control group. On day 28 post-treatment the FEC for the ivermectin-treated group was significantly (p<0.05) lower than that for the piperazine-treated and control groups. The high mean FEC for the piperazine-treated group on day 14 and 28 was due mostly to *Trichuris suis* (Figure 2). From day 68 post-treatment the FEC among the groups did not differ significantly (p>0.05). However, the FEC for ivermectin- and levamisole-treated groups remained consistently lower numerically than the FEC of the control and the piperazine-treated groups. The FEC for the ivermectin- and levamisole-treated groups did not differ significantly (p>0.05) at any time. However, the FEC for the ivermectin-treated group

![Graph](image)

**Figure 1:** Arithmetic mean faecal egg counts per gram of faeces (epg) for ivermectin-treated, amitraz/piperazine-treated, amitraz/levamisole-treated and control pigs in smallholder farms in Kikuyu Division, Kiambu District (August - December 2000)
remained consistently lower numerically than that of the levamisole-treated group, with the exception of day 68 post-treatment.

**Sarcoptic mange control**

The mean proportion of pigs positive for mites as determined by ear scrapings from Day 0 to Day 96 are presented in Figure 3. The pre-treatment mean proportion of pigs positive for mites in the four treatment groups did not differ significantly (p>0.05). The mean proportion of pigs positive for mites on day 7 post-treatment did not differ significantly (p>0.05) among the treatment groups. On day 14 post-treatment the ivermectin-treated group had a significantly lower proportion of pigs positive for mites compared to the control group (p<0.05). The proportion of pigs positive for mites in the ivermectin- and amitraz-treated groups did not differ significantly at any time (p>0.05). From day 14 post-treatment the mean proportion of pigs positive for mites did not differ significantly (p>0.05) among the groups. However, the proportions of pigs positive for mites were consistently lower in the ivermectin- and amitraz-treatment groups compared to the control group up to day 68 post-treatment.

The mean scratching indices (SI) for the pigs from Day 0 to Day 96 post-treatment are presented in Figure 4. The pre-treatment SI did not differ significantly (p>0.05) for the four treatment groups. On day 7 post-treatment the SI for ivermectin- and amitraz/levamisole-treatment groups were significantly (p<0.05) lower than the SI for the amitraz/piperazine-treatment group. Significantly (p<0.05) lower SI was noted in the ivermectin- and

![Figure 2: Arithmetic mean Trichuris faecal egg counts per gram of faeces (epg) for ivermectin-treated, amitraz/piperazine-treated, amitraz/levamisole-treated and control pigs in smallholder herds in Kikuyu Division, Kiambu District (August - December 2000)](image-url)
amitraz-treated groups compared to the control group on day 28 post-treatment. The SI for the four groups did not differ significantly (p>0.05) from day 68 post-treatment. The SI of the control group dropped drastically from day 14 post-treatment.

**Labour and drug costs**

The costs of the various inputs used are shown in Table 2. Overall, the total costs per pig were Kshs 40 ($ 0.5) for ivermectin, Kshs 25 ($ 0.31) for piperazine/amitraz and Kshs 21 ($ 0.26) for the levamisole/amitraz.

**Discussion**

This was a randomised placebo-controlled intervention study to evaluate the cost-effectiveness of various treatments against nematodes and sarcopic mange in pigs. The participation by the farmers throughout the study was excellent. The general willingness of the farmers to participate was accelerated by the use of free intervention drugs for their pigs.

A low (9%) reduction of FEC at day 14 as compared to day 0 was noted with piperazine and this was attributed to the low efficacy of piperazine against *Trichuris suis*. However, the significant reduction (>85%) of FEC at day 14 in pigs treated with ivermectin and levamisole suggested that both products were therapeutically effective against the nematodes found in the smallholder herds. These results are expected given that they confirm the current understanding about the efficacy of the studied anthelmintics against gastro-intestinal nematodes of pigs.

![Graph](image)

**Figure 3:** Proportion of pigs positive for mites in the ivermectin-treated, amitraz/piperazine-treated, amitraz/levamisole-treated and control pigs in smallholder farms in Kikuyu Division, Kikuyu District (August - December 2000)
Figure 4: Scratching indices for pigs in ivermectin-treated, amitraz/piperazine-treated and amitraz/levamisole-treated and control pigs in smallholder farms in Kikuyu Division, Kiambu District (August - December 2000)

The rise in FEC for the piperazine-treated herds was noted from day 7 while that for the ivermectin- and levamisole-treated animals was from day 28 post-treatment. The FEC for the ivermectin-treated group remained consistently lower than that for the levamisole-treated group throughout the study except for day 68. From these results, it would appear that the efficacy of ivermectin against the nematodes found in the smallholder herds was higher than that for the other anthelmintics and this was consistent with previous findings.2

The treatment with amitraz was repeated after 7 days in order to kill both mites and eggs. A seven day period was used so as to boost the first dose within a period less than the life cycle of the parasite, which is 10-15 days from egg to adult.1 On day 14 no significant difference in the proportions of pigs positive for mites between the ivermectin and the amitraz treatment groups could be determined; however, a significant difference was noted between ivermectin-treatment group and the control group, with the latter having a higher number of pigs positive for mites. It would appear that, using the application protocol of this study, the efficacy of ivermectin and amitraz are comparable. However, ivermectin activity appeared to persist for much longer time than that of amitraz. These results were consistent with previous observations about the efficacy of these acaricides against sarcoptic mange in pigs.1,2

From day 68 post-treatment up to the end of the study on day 96, there was a drastic decrease in the proportion of pigs positive for mites in the control group. Decreasing mite recoveries during the course of an infestation
has been observed. It has been suggested that mites initially multiply unchecked until infested pigs develop a hypersensitivity response, as a result of which mite numbers decline\textsuperscript{13}.

There was a decrease in the values of the calculated scratching indices after treatment with the acaricides. This observation confirms the usefulness of using scratching index as an indirect measure of mange infestation\textsuperscript{19,13}. However, there was a decrease in the scratching index for the controls as from day 28 onwards even though the proportion of pigs positive for mites was increasing implying that the scratching index may not be very reliable. However, smallholder farmers could still use the pruritic behaviour as a low-cost means of evaluating the mange status in their herds.

This study concentrated on the cost-effectiveness of different drugs. The benefits of the interventions for example in terms of improved growth performance were not a concern in this study as considerable variability in growth rates among the smallholder herds were expected; partly due to the expected variability in infestation levels\textsuperscript{9}, the erratic, non-standard diets used in the smallholder herds, severe under-nutrition of pigs in most of the herds and the inbreeding and crossbreeding that has been observed to occur in the smallholder herds\textsuperscript{14}.

Cost-effective control of livestock diseases is achieved when the marginal return from disease reduction is equal to or higher than the marginal cost of a given increment in disease control efforts\textsuperscript{4}. Theoretically, the preferred type of an economic evaluation is the cost-benefit approach in which costs as well as benefits are measured in monetary units\textsuperscript{4}. However, due to the limitations outlined earlier, solely a relative cost-effectiveness analysis was carried out to determine how a reduction of the two parasitic diseases could be achieved at minimum cost. Ivermectin and amitraz/levamisole combinations were the most effective drugs against mange and gastro-intestinal nematodes in the study herds. Though not significantly different, the efficacy of ivermectin was superior to that of amitraz/levamisole for the two parasitic diseases. However, its cost is probably prohibitive in the smallholder system. In this production system, the aim would be to optimise production by reduction of worm and mange burdens rather than maximising output by eradication of the parasites, an exercise not currently possible in this production system. The cost of piperazines was comparable to that of levamisole; however, piperazine had a low efficacy against \textit{Trichurus suis} which appeared to be prevalent in the smallholder herds. Therefore, from the technical and economic data the amitraz/levamisole combination appeared to be the most cost-effective treatment against gastro-intestinal nematodes and mange in pigs in the smallholder herds. The costs presented were calculated for a period of three months. They represent the short-term costs arising from a deworming/mange control programme applied to a group of pigs. Estimation of the costs during this short-evaluation period was thought to be reasonable as the anthelmintics and acaricides used were not likely to have long-term effects on the nematodes and mange and both costs and the biological effects/benefits of treatments were realised within the short-evaluation period. The short-cycle period for pigs and the management practices of stall feeding of pigs all the year round, thus minimizing the year-to-year variation, further justified the calculation scheme for costs for this period.

In other studies carried out in smallholder farming systems, the cost of family labour is assumed to be abundant and is normally not incorporated in the computation of the costs, leading to an underestimation of
the real costs\textsuperscript{10}. In the current study, the cost of the family labour was included in all computations in order to approximate the real cost of each treatment and to allow a valid comparison across the farms.

Conclusions

Ivermectin alone and an amitraz/levamisole drug combination were effective against sarcoptic mange and gastro-intestinal nematodes of pigs. However, an amitraz/levamisole drug combination was the most cost-effective. Although reduced morbidity as a result of using cost-effective drugs against sarcoptic mange and gastro-intestinal nematodes might result in an increase in gross revenue for the smallholder farmers it may still be necessary to determine the benefits in terms of weight gain in order to determine the net profitability of the interventions.

Acknowledgement

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

References


Received for publication on 19th December, 2005
HELMINTHIASIS IN FREE-RANGING INDIGENOUS DOMESTIC POULTRY IN KENYA

B. A. OKECH1,3*, L. W. IRUNGU1 and J. E. COOPER2

1Department of Zoology, University of Nairobi, P. O. Box 30197, Nairobi, Kenya.

2Department of Wildlife and Animal Resources Management, Faculty of Veterinary Medicine, Makerere University, Uganda. (Present address. School of Veterinary medicine, University of the West Indies, St Augustine, Trinidad and Tobago).

3Centre for Biotechnology, Research and Development, Kenya Medical Research Institute, P. O. Box 54840, Nairobi, Kenya

L’HELMINTHIASE CHEZ LA VOLAILLE DOMESTIQUE LOCALE EN LIBRE PARCOURS AU KENYA

Résumé

Au Kenya, les données sur l’helminthiasis aviaire sont rares et il y a très peu de recherches menées sur cette maladie à cause de ses symptômes chroniques et moins visibles, qui sont difficiles à discerner. Afin de combler cette lacune, nous avons examiné 604 intestins de poulet recueillis des abattoirs locaux au Kenya et nous avons ensuite visité 22 fermes dans la Province centrale, qui pratiquent l’élevage en libre parcours des poulets locaux. Nous avons distribué un questionnaire sur les signes cliniques de l’helminthiasis et les systèmes d’exploitation avicole pour savoir si les éleveurs pouvaient reconnaître les poulets malades dans leur troupeau. Quatre-vingt-dix pour cent des intestins recueillis dans les abattoirs étaient positifs pour un helminthe ou plus, y compris, entre autres, Heterakis spp (28%), Strongyloides spp (24%), Ascaridia galli (14%), Acuaria spp (13,6%), Tetrameris spp (2,5%) et Davainea spp (2,1%). Sur les 22 fermes, une ou plus signalait un état anormal dans leur troupeau. On a observé : une baisse de ponte chez 90% ; la faiblesse des pattes et la flente fine et tachée de sang (59%) ; la maturité tardive (> 8 mois) chez 46%. Quatre-vingt-deux pour cent des réponses reçues des fermes concordaient avec les signes cliniques liés aux helminthes identifiés chez les volailles lors de la coprologie.

Mots-clés: Helminthiasis, libre parcours, local, poulet, Gallus domesticus, Kenya.

Summary

In Kenya data on poultry helminthiasis are scarce and its research has received little attention owing to the less visible and chronic symptoms of helminthiasis that are difficult to discern. To bridge this gap, we examined 604 chicken guts from local slaughter houses in Kenya and then visited 22 homesteads in Central Province rearing indigenous free ranging chicken. A questionnaire dealing with clinical signs of helminthiasis and poultry management practices to assess whether the farmers discerned ill health in their flock was administered. Ninety percent of the slaughter house guts were positive for one or more helminth parasites, including Heterakis spp (28%), Strongyloides spp (24%), Ascaridia galli (14%), Acuaria spp (13.6%), Tetrameris spp (2.5%) and Davainea spp (2.1%) among others. Of the 22 homesteads, one or more reported abnormal conditions in their flock. Ninety percent observed depressed egg-laying, 59% saw weakness in legs and slimy/bloody stool, while 46% observed late maturity (>8months). Eighty two percent of the homesteads feedback tallied with the clinical signs associated with the helminth parasites identified from their poultry at coprology.

Key Words: Helminthiasis; Free ranging; Indigenous; Chicken; Gallus domesticus; Kenya.

*Corresponding author e-mail: okech@whitney.ufl.edu
Introduction

Indigenous chickens (Gallus domesticus) are among the local assets of rural families, who make up 80% of the total population in Kenya. It is estimated that 90% of rural homesteads in Kenya keep and rear indigenous chickens usually in small flocks of about 20 birds\textsuperscript{1,2,3}. These chickens are believed to be harder and tolerant of the harsh environmental conditions to which they are exposed than are exotic breeds. While recognizing that indigenous birds may be tolerant, their high mortality, low growth rates, small mature weights and low egg production are of major concern to poultry development in Kenya\textsuperscript{4}. One of the major reasons for the low productivity is the burden of diseases borne by these chickens and is well recognized as a constraint in the development of the indigenous poultry industry in Kenya\textsuperscript{4}. Many diseases of poultry responsible for significant losses in the poultry industry in Kenya have been studied and control measures put in place. However, helminthiasis has received very little attention due to the fact that the clinical signs are less visible, difficult to discern and often chronic\textsuperscript{5}. Helminthiasis in poultry can contribute to great losses in productivity of poultry\textsuperscript{7}. In the rural areas with limited resources, indigenous free-ranging poultry become infected with helminth parasites very readily because of the increased contact with the reservoir and intermediate hosts\textsuperscript{8}. In Kenya data on helminthiasis in free-ranging poultry is scarce, with only few reports indicating the existence of this infection in domestic chickens\textsuperscript{5,8}. The relative convenience and low cost of the free-ranging production systems for indigenous poultry is quite attractive to many and hence the need to control the diseases that affect indigenous poultry. This study therefore investigated helminthiasis in free ranging indigenous poultry in Kenya in a bid to bridge the information vacuum and to build on to a database that may be useful in intervention strategies.

Methodology

Study site. This study was conducted within Nairobi Province and in 2 locations (Ol'Ngarua location, in Laikipia District and Leshau location, in Nyandarua District) in Central Province. Nairobi province has cool climatic conditions with a rainy season between April and July and October and December. The temperatures average between 200\textdegree{}C and 270\textdegree{}C during the dry season while much of the other periods experience intermittent rainfall and cool temperatures throughout the year. Nyandarua and Laikipia District in Central province lie on the edges of the Great Rift Valley. Temperatures are cool throughout the year with annual rainfall of between 1000 – 2500 mm per annum.

Prevalence of helminths: Abattoir survey.

Sample collection in abattoirs:

In Nairobi, the study was based at ‘Burma market’ and ‘Kariokor market’, the 2 major slaughter houses run and managed by the Nairobi City Council. Burma market, located along Jogoo road and Kariokor market along Juja Road, both sell a daily average of approximately 2000 head of free ranging indigenous poultry to Nairobi residents. Arrangements were made with the slaughterhouses for weekly visits in order to purchase the entire alimentary canal of indigenous poultry. The gut specimens were immediately stored in 5% formal saline solution and labeled with details showing the sample number, place of origin, name of slaughterhouse and the date when the bird was processed. The samples were stored in cupboards away from sunlight. Every 2 days,
the samples were collected and transported to the laboratory for further processing. Recognizing the fact that poultry trade is dominated by middlemen, a follow up to the areas where most of the poultry originated was arranged.

Prevalence of helminths. Homestead study. In trying to evaluate whether smallholder farmers observed chronic signs of ill health (typical of helminthiasis - see ref 6) in their indigenous free-ranging chickens, a questionnaire written in English with translations into the local Kikuyu language was distributed to the 22 homesteads 2 weeks prior to the visit. The questionnaire dealt with clinical signs of poultry helminthiasis and poultry management practices. Questions on clinical signs were obtained from a reference book6 on parasitic infections of domestic animals. These questions included clinical spectra of helminthiasis for example, depressed egg laying, late maturity (>30 weeks), lethargy, paralysis in the legs and persistent slimy and bloody stool. Other questions on poultry management practices related to the system of flock rearing, the place of roosting, feed supplementation, veterinary medicines, mixed bird farming and provision for clean drinking water within the compound. The questionnaires were distributed by a local field assistant (O-level education), who sometimes assisted in obtaining accurate questions and/or answers through translation of the local language. The questionnaires were only given to the homesteads which had agreed to co-operate in the study. Because questions were both closed (with options) and open-ended (without options), homestead responses that described flock attitude present in the questionnaire were taken as affirmative or positive. A limited number of birds were purchased (about 2-3 birds per household) from each of the 22 homesteads visited. Immediately after purchase, the birds were sacrificed by cervical dislocation and the entire alimentary canal removed, labeled appropriately and preserved in 5% formal saline. These samples were later transported to the laboratory for investigation. The respondents’ feedback in the questionnaires

| Par...
Table 2. The locality of origin of indigenous free-ranging poultry and the proportion with or without helminthiasis.

<table>
<thead>
<tr>
<th>Locality</th>
<th>Positive</th>
<th>Negative</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machakos</td>
<td>2.3% (14)</td>
<td>0.0% (0)</td>
<td>2.3% (14)</td>
</tr>
<tr>
<td>Bomet</td>
<td>26.8% (162)</td>
<td>4.1% (25)</td>
<td>31.0% (187)</td>
</tr>
<tr>
<td>Kitui</td>
<td>22.0% (133)</td>
<td>2.3% (14)</td>
<td>24.3% (147)</td>
</tr>
<tr>
<td>Nyahururu</td>
<td>4.5% (27)</td>
<td>0.0% (0)</td>
<td>4.5% (27)</td>
</tr>
<tr>
<td>Nairobi</td>
<td>1.0% (6)</td>
<td>0.0% (0)</td>
<td>1.0% (6)</td>
</tr>
<tr>
<td>Makueni</td>
<td>33.6% (203)</td>
<td>3.3% (20)</td>
<td>37.9% (223)</td>
</tr>
<tr>
<td>Total</td>
<td>90.2% (545)</td>
<td>9.8% (59)</td>
<td>100% (604)</td>
</tr>
</tbody>
</table>

was compared with the results of the helminth infections in the guts of the purchased birds. A contrast table was constructed and conflicting results were recorded as false and concurring results as true.

Results

Prevalence of helminth
Abattoir survey

A total of 604 gut specimens from indigenous free-ranging poultry were examined for helminth infections. One or more species of parasites was recovered from the guts, either as adult worms or from egg identification; these included both nematodes and cestodes, with major species represented in each sub group (Table 1) and one species of trematode. The prevalence of the helminth parasites was recorded as follows: Heterakis spp (28%), Strongyloides spp (24%), Ascaridia galli (14%), Aucaria spp (13.6%). However other helminth parasites noted but in very small samples were Tetrameres spp (2.5%), Davainea spp (2.1%), Capillaria spp (1.2%), Prothogonimus spp (1.2%), Oxyspiura spp (0.8%), Syngamus trachea (0.9%), Subulura spp (0.6%), Trichostrongylus spp (0.3%). The helminth parasites and prevalence varied with the place of origin of the birds (Table 2). A higher prevalence was observed in birds originating from Makueni in Eastern Province, followed by Bomet in the Western Ridge of the Rift Valley, Kitui in Eastern Province, Nyahururu on the Eastern ridge of the Rift Valley, Machakos in Eastern Province and then Nairobi, in that order. Although fewer samples were obtained in certain areas which may not be representative for the whole region, it nevertheless indicated the worm species present in that area.

Prevalence of helminths. Homestead study and questionnaire feedback. More than 90% of the respondents observed low productivity in terms of egg-laying, 59% reported weakness in the legs and slimy and bloody stool in their flocks, while 46% of the homesteads noted that the birds matured late, which they estimated at more than 8 months after hatching (Table 3). 36.5% reported paralysis even though a similar number of respondents could not identify this condition (paralysis) in their flock. From laboratory findings, parasite species (adult/egg stage) recovered from the homesteads visited were not strikingly different although birds from a number of homesteads appeared not to have helminthiasis. The most common helminth parasite recovered from the birds bought from the homesteads included Heterakis
isolanchae, Strongyloides spp, Davainea proglottina and Acuaria spp. Mixed in infections was observed in some of the birds and the estimated worm burden was as high as 13 adult worms per single bird (Table 4). Using clinical signs in infected birds specific for a particular helminth parasite, a comparison was made against the flock attitude reported by the farmers and the parasite species recovered from the poultry purchased from their farms. The clinical signs associated with the helminth parasites recovered in the free-ranging domestic chicken purchased from the homesteads included listlessness (lethargy), depression, low productivity in mild infections of Heterakis isolanchae, dull plumage, slow movement, leg paralysis in severe Davainea proglottina infection; droopiness, emaciation, pale mucous membranes in moderately severe Acuaria spp infection; and low productivity in mild Strongyloides spp infection.

All the 22 homesteads that were visited reported one or more abnormal condition in the general attitude of the flock (Table 4). Eighty two percent of the respondents were able to identify signs of sickness or ill health in their flock. The low productivity in terms of few eggs, weakness in the legs of chicken, slimy and bloody stool closely tallied with the species of helminth identified. The farmers' reports and laboratory results showed the presence of one or more species of helminths affecting the poultry (Table 4). The questionnaire therefore generally indicated that rural homesteads keeping indigenous free-ranging poultry could observe a general state of ill health of their poultry that might be associated with helminthiasis.

Discussion

This study has shown that there is a high prevalence of helminth infection in free ranging domestic poultry in Kenya. In addition, the distribution of helminthiasis appears to be widespread in the country, as the infections were observed in poultry originating from all the areas. Also, based on the results of the questionnaire from the small holder farmers, the study has demonstrated that rural farmers are able to observe ill-health in their poultry stock by observing their behaviour and that these observations can be captured accurately by using respondent questionnaires. In addition, the study shows the possibility of using respondent questionnaires in detecting the presence of helminthiasis in indigenous domestic poultry and even the possibility of mapping out the prevalences' of poultry diseases in the country.

Heterakis spp, S. avium and A. galli were the most commonly detected nematode while Davainea proglottinna was the most prevalent cestode parasite. The nematodes that were found in the poultry are cosmopolitan, occurring in many parts of the world. Many of the nematodes have an indirect

<table>
<thead>
<tr>
<th>Clinical signs by respondents</th>
<th>Signs present</th>
<th>Signs absent</th>
<th>No response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late Maturity</td>
<td>46%</td>
<td>40%</td>
<td>14%</td>
</tr>
<tr>
<td>Few eggs</td>
<td>91%</td>
<td>4.5%</td>
<td>4.5%</td>
</tr>
<tr>
<td>Slimy and bloody stool</td>
<td>59%</td>
<td>27%</td>
<td>14%</td>
</tr>
<tr>
<td>Weakness</td>
<td>59%</td>
<td>18%</td>
<td>23%</td>
</tr>
<tr>
<td>Paralysis</td>
<td>36.5%</td>
<td>27%</td>
<td>36.5%</td>
</tr>
</tbody>
</table>
Table 4. A comparison of the clinical signs reported by the homesteads in response to questionnaires and the helminth parasites recovered from the guts of birds purchased from the same homesteads.

<table>
<thead>
<tr>
<th>Home No.</th>
<th>Signs reported by smallholder farmers (respondents)*</th>
<th>Parasites recovered from birds</th>
<th># of birds</th>
<th>worms/bird</th>
<th>Tally</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Late maturity; Few eggs; Slimy bloody diarrhoea; Weakness</td>
<td><em>Heterakis</em> spp (13); <em>Strongyloides</em> spp. (12)</td>
<td>3</td>
<td>8.3</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Late maturity; Slimy bloody diarrhoea</td>
<td><em>Strongyloides</em> spp (9), <em>Heterakis</em> spp (4)</td>
<td>4</td>
<td>3.3</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Few eggs; weakness</td>
<td><em>Heterakis</em> spp (16); <em>Strongyloides</em> spp (11)</td>
<td>3</td>
<td>9.0</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Few eggs; Slimy bloody diarrhoea; Weakness</td>
<td><em>Davainea</em> spp (5)</td>
<td>3</td>
<td>1.7</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Late maturity</td>
<td><em>Strongyloides</em> spp. (17)</td>
<td>3</td>
<td>5.7</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Few eggs; Late maturity</td>
<td><em>Heterakis</em> spp (23)</td>
<td>3</td>
<td>7.7</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Late maturity; Few eggs; Slimy bloody diarrhoea; Weakness</td>
<td>Negative (0)</td>
<td>3</td>
<td>0.0</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Few eggs; Slimy bloody diarrhoea; Weakness</td>
<td><em>Strongyloides</em> spp (20); <em>Acuaria</em> spp (3)</td>
<td>3</td>
<td>7.7</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>Late maturity; Slimy bloody diarrhoea</td>
<td><em>Heterakis</em> spp (14), <em>Acuaria</em> spp (5)</td>
<td>3</td>
<td>6.3</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>Late maturity; Slimy diarrhoea</td>
<td><em>Heterakis</em> spp (26)</td>
<td>2</td>
<td>13.0</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>Few eggs</td>
<td><em>Heterakis</em> spp (19)</td>
<td>2</td>
<td>9.5</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
<td>Late maturity; Few eggs; Slimy bloody diarrhoea</td>
<td><em>Davainea</em> spp (7); <em>Strongyloides</em> spp (11)</td>
<td>3</td>
<td>6.0</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>Late maturity; Few eggs; Slimy diarrhoea</td>
<td><em>Strongyloides</em> spp (9)</td>
<td>3</td>
<td>3.0</td>
<td>1</td>
</tr>
<tr>
<td>14</td>
<td>Few eggs; Slimy bloody diarrhoea; Weakness (sometimes paralysis)</td>
<td><em>Heterakis</em> spp (9); <em>Davainea</em> spp (4); <em>Acuaria</em> spp (8)</td>
<td>3</td>
<td>7.0</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>Many eggs; Weakness (sometimes paralysis)</td>
<td><em>Davainea</em> spp (4)</td>
<td>1</td>
<td>4.0</td>
<td>1</td>
</tr>
<tr>
<td>16</td>
<td>Few eggs; Diarrhoea; Weakness (sometimes paralysis)</td>
<td><em>Strongyloides</em> spp (17)</td>
<td>3</td>
<td>5.7</td>
<td>1</td>
</tr>
<tr>
<td>17</td>
<td>Slimy bloody diarrhoea; Weakness (sometimes paralysis)</td>
<td><em>Heterakis</em> spp (13)</td>
<td>3</td>
<td>4.3</td>
<td>1</td>
</tr>
<tr>
<td>18</td>
<td>Few eggs; Bloody stringy diarrhoea; Paralysis</td>
<td><em>Strongyloides</em> spp (6)</td>
<td>3</td>
<td>2.0</td>
<td>1</td>
</tr>
<tr>
<td>19</td>
<td>Few eggs; Paralysis</td>
<td><em>Strongyloides</em> spp (15); <em>Heterakis</em> spp (9)</td>
<td>3</td>
<td>8.0</td>
<td>1</td>
</tr>
<tr>
<td>20</td>
<td>Few eggs; Weakness</td>
<td>None (0)</td>
<td>2</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>21</td>
<td>Late maturity; Few eggs;</td>
<td>None (0)</td>
<td>3</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>22</td>
<td>Slimy bloody diarrhoea</td>
<td>None (0)</td>
<td>2</td>
<td>0.0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Signs tallying with the clinical signs associated with a particular helminth parasite are designated as 1 to indicate concurrence with the questionnaire or 0 for no concurrence. The number of birds purchased per homestead is in parenthesis.
life cycle, often having to pass through one intermediate host (mainly beetles, cockroaches, grass hoppers, and even snails). Most of these intermediate hosts occur in large numbers outdoors and are easily caught by the chicken. Infection with A. galli, the life-cycle of which is direct, usually results from ingestion of the embryonated eggs directly from the ground. Many of the homesteads that were visited reported that they provide their flock with kitchen leftovers as feed supplementation. This is usually spread in the open field on the ground for the chicken to pick, where it comes into contact with the soil, which harbours the infective stages of the Ascaridia eggs. The kitchen waste can also attract a considerable number of cockroaches, flies and even crickets. It is highly likely that the flock could also forage on these intermediate hosts, leading to a high rate of infection.

The study also demonstrates that questionnaires can be effective tools for obtaining important information on poultry helminthiasis. This is clearly demonstrated from the fact that not only did all the interviewed homesteads answer all the questions asked concerning their poultry, but they were also able to report on abnormal conditions after observing the behaviour and performance of the flocks. The translation of the questions into the local Kikuyu language and the participation of a local literate resident farmer who wrote and translated the respondents' feedback, contributed to the broad acceptance of the questionnaire. It is recommended that translated versions be made part and parcel of any questionnaire directed at local residents. More than 90% of the homesteads reported that they observed low productivity in the form of egg output. Although this cannot entirely be due to helminthiasis, the fact that 46% identified late maturity and 59% weakness of the legs helps to support the laboratory findings where a 95% prevalence rate of helminthiasis was observed. In addition, many of the parasites that were found are those that do not cause acute illness or fatalities but mainly derive nutrients from the host with no immediate sign of harm to the host. Infections which cause acute illnesses in poultry such as Newcastle Disease (NCD) and coccidiosis, which are caused by viruses and protozoan parasites respectively, are among others that are easily recognized by farmers. During outbreaks, these diseases kill many birds and farmers have become familiar with them and know how to identify them accurately by their clinical signs. The questionnaire clearly distinguished these categories of diseases and the options presented in the "closed" questions ruled them out all together. Therefore, we can have confidence in the ability of the questionnaire to capture the farmers' perceptions on the presence of helminthiasis in their flock.

The management practices reported in the questionnaires were indicative of the conducive environment that could propagate helminths, for instance, in most cases the roosting place was confined to one area, opening up the possibility of cross-infection in the flock, no clean water was provided (birds drank from stagnant pools of water that may also be used by wild birds), and treatment with veterinary medicines was only carried out during outbreaks of acute infections. The chronic diseases such as most helminthiases, go unnoticed and were left to self-resolve by themselves. Therefore, through the questionnaire, it has been shown that the local peasant farmer can identify cases of chronic ill-health, which is associated with helminthiasis (although the clinical signs can also be associated with other health problems), and also that no effort was directed at finding out what was hindering productivity of the flock.
Acknowledgements.

We wish to thank the superintendents of the slaughter houses and the Nairobi City Council for allowing us to purchase and collect gut specimens, Nicodemus Muia of Zoology Department, University of Nairobi for technical assistance in processing the gut samples and Diana Ruchugo, a veterinary student from School of Veterinary Medicine, University of Nairobi for participating in the identification of the worms. We appreciate the efforts of Samuel Ndung'u and the late Mugo Kagoiya who were local residents and farmers in Leshau and Of'Ngara Location for the questionnaire distribution and poultry purchases, and to all the homesteads and the local farmers who kindly agreed to co-operate in the study. This study was supported by grants from the DFID, Kenya Agricultural Research Institute's (KARI) Agricultural Research Fund (ARF) No. ARF/LSKP/101023/01.

References


Received for publication on 30th March, 2006
VENTRICULAR ENCEPHALITIS ASSOCIATED WITH LEUKAEMIC LYMPHOSARCOMA IN A BOVINE CALF

A.N. MAINA, T.A. NGATIA, D.I. KARIOKI, P.K. GATHUMBI, T.A. ABUOM, P.N. GITONGA and V.J. CHEMIS

1Department of Veterinary Pathology and Microbiology, Faculty of Veterinary Medicine, University of Nairobi, P.O Box 29053 00625 Kangemi, Nairobi, Kenya.

2Department of Clinical Studies, Faculty of Veterinary Medicine, University of Nairobi, P.O Box 29053 00625 Kangemi, Nairobi, Kenya.

ENCEPHALITE VENTRICULAIRE LIEE AU LYMPHOSARCOME LEUCEMIQUE CHEZ UN VEAU

Résumé

Une velle Ayrshire âgée de trois mois était enmenée à la clinique, avec un problème d'hypertrophie généralisée du ganglion lymphatique et de croissance (elle n'arrivait pas à bien se développer). L'examen physique a révélé l'hypertrophie de tous les ganglions lymphatiques périphériques et des hémonodes. Une biopsie du ganglion lymphatique a montré des lymphocytes immatures à différentes phases de la mitose. L'examen d'un prélèvement sanguin a révélé une anémie normocytique normochromique, avec beaucoup de globules rouges immatures et difformes. Même si le nombre de leucocytes était dans les normes, les lymphocytes constituaient la majorité (94%) et il n'y avait que 6% de neutrophiles. On n'a pas trouvé d'autres leucocytes. Il y avait beaucoup de lymphocytes immatures et difformes ; de même qu'on a aussi trouvé des neutrophiles immatures et difformes. C'est ainsi qu'un diagnostic clinique de lymphosarcome leucémique a été fait. La velle est morte deux semaines après son admission à la clinique. La necropsie a révélé l'émaciation, l'hypertrophie des ganglions lymphatiques avec détérioration des hémonodes, du foie, des reins et de la moelle osseuse.

On a observé au microscope des infiltrations lymphocytaires dans le foie, les reins, la rate, les poumons, l'abomasum, les leptoméninges du cerveau ainsi que dans les parties subependymales du système ventriculaire.

Summary

A female Ayrshire calf aged three months was referred to the clinic with a history of generalized lymph node enlargement and failure to thrive. Physical examination revealed enlargement of all peripheral lymph nodes and haemonodes. A lymph node biopsy showed many immature lymphocytes in various phases of mitosis. Examination of a blood sample revealed normocytic normochromic anaemia, with many immature and abnormally shaped red blood cells. Although leucocyte count was within the normal range, lymphocytes were the majority (94%), with neutrophils constituting only 6%. Other leucocytes were absent. There were many immature and abnormal lymphocytes, similarly, there were immature and abnormal neutrophils. As a result, a clinical diagnosis of leukaemic lymphosarcoma was made. The calf died two weeks after admission. Postmortem examination revealed emaciation, enlargement of all lymph nodes, with involvement of the haemonodes, liver, kidneys and bone marrow.

Microscopically, there were lymphocytic infiltrations in the liver, kidneys, spleen, lungs, abomasum, leptomeninges of the brain and in the subependymal areas of the ventricular system.

*Corresponding author email: vetpath@uonbi.ac.ke
Introduction

Lymphoid tumours are the most common groups of tumours in domestic animals. Lymphosarcoma of cattle appears to be world wide in distribution, including Kenya\textsuperscript{1,2}. Lymphosarcoma in cattle can broadly be classified on epidemiological basis into two types, i.e. enzootic bovine leucosis (EBL) and sporadic bovine lymphosarcoma (SBL). The sporadic form can be classified as juvenile (calf), adolescent (thymic) and skin forms. The multicentric enzootic form affects adult cattle and is caused by a C-type oncovirus, a member of the family Retroviridae\textsuperscript{1,3,4}.

The juvenile SBL affects calves about six months of age\textsuperscript{5} or younger\textsuperscript{6,7} and is occasionally found in neonates\textsuperscript{8} and foetuses\textsuperscript{9,10,11}. Affected calves show loss of body weight, generalized lymph node enlargement, weakness\textsuperscript{5} and, posterior paresis. The distribution pattern of lesions in the lymph nodes, liver, spleen and bone marrow, closely resembles that of the leukemic form of lymphoid neoplasia, although neoplastic cells are not found in circulation. Other organs that may be affected include the thymus, heart, kidneys and uterus\textsuperscript{1,5,12}.

From the literature, it appears that lesions associated with the calf form of lymphosarcoma are not fully known. This paper therefore describes the gross, microscopic and haematological changes in a calf with lymphosarcoma.

Materials and methods

Case History.

A female Ayrshire calf aged three months from the Faculty of Veterinary Medicine teaching farm, was reported sick with a history of progressive emaciation, generalized lymph node enlargement and a mild fever (39.8\textdegree C), and it was treated for East Coast fever (ECF). Four weeks later, the lymph nodes had increased in size and it was therefore referred to the clinic for further investigation.

On admission to the clinic, the calf was subjected to thorough physical examination. A blood sample was taken and analyzed for various parameters using cell counter-MS4 (France), and smears prepared. A lymph node was aspirated and smears prepared. Both blood and lymph node aspirate smears were stained with Giemsa and examined microscopically. A tentative diagnosis of lymphosarcoma was made and therefore no treatment was given. The calf was kept under observation, during which period it was fed on hay and calf pencils and water provided ad libitum. The calf died two weeks after admission.

Postmortem examination was carried out and all abnormalities noted. Samples for histopathology were taken from various organs and fixed in 10\% formalin solution. After fixation, the tissues were processed, sectioned at a thickness of 5 microns and stained with haematoxylin and eosin. In addition to this, postmortem records from this herd were reviewed specifically for the occurrence of lymphosarcoma.

Results

Clinical findings

On physical examination, the calf was emaciated and had mild diarrhoea. All the superficial lymph nodes i.e. prescapular, parotid and precrural were markedly enlarged and were visible from a distance (Figure 1). The haemonodes were also enlarged. On
Figure 1. Photograph of the calf with lymphosarcoma, showing loss of body condition, enlargement of superficial lymph nodes; parotid (p), prescapula (s) and precrural (c) and haemonodes (h).

Table 1. Haematological results of a 3 month female Ayrshire calf with juvenile sporadic bovine lymphosarcoma

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Observed value</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red blood cell (RBC)</td>
<td>3.96 ×106 /μl</td>
<td>6.0-11.0 × 106 /μl*</td>
</tr>
<tr>
<td>Packed cell volume (PCV)</td>
<td>16.3 %</td>
<td>25-50 %*</td>
</tr>
<tr>
<td>Haemoglobin concentration (Hb)</td>
<td>6.4 g/dl</td>
<td>8-15g/dl*</td>
</tr>
<tr>
<td>Platelet count</td>
<td>8.8×104 /μl</td>
<td>1.0-8.0×105 /μl*</td>
</tr>
<tr>
<td>Plasma proteins</td>
<td>6.0 g/dl</td>
<td>6.0-8.0 g/dl**</td>
</tr>
<tr>
<td>White blood cell (WBC)</td>
<td>12.33 × 103 /μl</td>
<td>4-15 × 103 /μl*</td>
</tr>
<tr>
<td>Mean corpuscular Haemoglobin concentration (MCHC)</td>
<td>39.2 %</td>
<td>30-40 %*</td>
</tr>
<tr>
<td>Mean corpuscular haemoglobin</td>
<td>16.12 pg/μl</td>
<td>11-17.0 pg/μl*</td>
</tr>
<tr>
<td>Lymphocyte</td>
<td>94 %</td>
<td>45-75 %**</td>
</tr>
<tr>
<td>Neutrophils (Mature &amp; immature)</td>
<td>6 %</td>
<td>15-47 %**</td>
</tr>
<tr>
<td>Monocytes</td>
<td>0</td>
<td>2-7 %**</td>
</tr>
<tr>
<td>Eosinophils</td>
<td>0</td>
<td>2-20 %**</td>
</tr>
<tr>
<td>Basophils</td>
<td>0</td>
<td>0-2 %**</td>
</tr>
</tbody>
</table>

Key: * Values obtained from the cell counter MS4 (France), **Values from Mercks manual.13
palpation, all lymph nodes, including the popliteal and supramammary lymph nodes were markedly enlarged. The heart and respiratory rates were increased.

**Haematology**

Haematological parameters are presented in Table 1. The following parameters were lower than normal: Red blood cells (RBC) count- 3.96×10⁶ /µl; packed cell volume (PCV)- 16.3 %; Haemoglobin concentration (Hb)- 6.4g/dl and platelet count- 8.8×10⁴ /µl. These following parameters were within the normal range: plasma proteins- 6.0g/dl; white blood cell (WBC) count- 12.33×10³ /µl; mean corpuscular haemoglobin concentration (MCHC)- 39.2% and mean corpuscular haemoglobin (MCH)- 16.12pg/µl.

Examination of blood smears showed anisocytosis and abnormally shaped red blood cells (leptocytes, acanthocytes and crenated cells) (Figure 2). There was a high proportion of immature cells (reticulocytes) with occasional nucleated red blood cell (metarubricytes).

Differential leukocyte count showed lymphocytes to contribute the highest proportion 94% of the leukocytes. There was a high proportion of immature cells (Figure 2) including lymphoblasts and prolymphocytes, some of which had abnormal shapes and appearance. The proportions of other leukocytes were lower than normal, with neutrophils constituting 6% of the WBC count. Immature neutrophils, which included band cells, myelocytes and metamyelocytes, were occasionally encountered. Monocytes, eosinophils and basophils were not observed.

**Lymph node smear**

Lymph node smears revealed increased immaturity of lymphocytes (Figure 3) with blast cells- 20.0 %; mitotic figures- 16.0 %; atypical (abnormal shaped) lymphocytes- 31.0 % and mature normal lymphocytes- 33.0 %. Some of the lymphoblasts had vacuoles in their cytoplasm.

**Postmortem findings**

**Gross findings**

At necropsy, there was marked enlargement (2-5 times) of both the peripheral and internal lymph nodes and haemomonodes. The lymph nodes were soft in consistency,
and on cut surface, they appeared grey or greyish-white, with others having haemorrhagic areas. Generally they had a homogenous amorphous appearance with no distinction between the cortex and medulla.

The bone marrow of long bones had grayish areas resembling lymphoid tissue. This was observed to displace the bone marrow to the periphery. The liver and kidneys showed numerous pale foci on the surfaces, and pale foci and streaks on cut surfaces. In the spleen, the malphighian corpuscles were prominent. In the lungs there was moderate degree of oedema (with froth in the airways).

**Histopathology**

The brain showed mononuclear cells (lymphocytes) beneath the ependyma of the ventricular system (non-suppurative ventricular encephalitis) (Figure 4). The overlying ependymal cells were hypertrophic, sometimes degenerate and in some places

**Figure 3.** Photomicrograph of a lymph node smear from a calf with lymphosarcoma, showing abnormal lymphocyte (thick arrows) and a mitotic figure (thin arrow). Also note various sizes of near normal lymphocytes (smaller cells).

**Figure 4.** Section from the brain of a calf with lymphosarcoma, showing lymphocytic cells infiltration (thick arrows) beneath the ependyma (thin arrows). H/E ×100
became detached. The meninges in some areas were thickened due to lymphocytic infiltrations (Figure 5).

The lungs showed interstitial pneumonia characterized by almost uniform alveolar wall thickening due to mononuclear cells infiltration (mainly lymphocytes) (Figure 6). In some areas there was light pink staining fluid (oedema). There were cellular (lymphocytes) aggregations around some bronchioles and blood vessels.

In the lymph nodes, the usual architecture was obliterated so that the demarcation between the cortex and the medulla was indistinct. This gave a more or less uniform appearance of the two zones. Occasionally, nodular (follicular) aggregations of lymphocytes were observed in the cortex. There were many mitotic figures.

In the spleen there was increased cellularity in the red pulp, so that the malphighian corpuscles were not clearly

![Figure 5](image1.png)

**Figure 5.** Section from the brain of a calf with lymphosarcoma showing thickening of the meninges (due to lymphocytic infiltration) (thick arrows). Also note the near normal meninges (thin arrows). H/E×100

![Figure 6](image2.png)

**Figure 6.** Section of the lung from a calf with lymphosarcoma showing more or less uniform alveolar wall thickening due to lymphocytic infiltration. Note lymphocytic aggregations (l) between two bronchioles (b). H/E ×100
discernible. The lymphocytes were in different stages of maturation.

The bone marrow was displaced to the periphery by the advancing neoplastic lymphoid tissue, which had been discernible grossly (Figure 7). The lymphoid cells were in different stages of maturation and there were many mitotic figures.

In the liver there were lymphocytic infiltrations in form of foci or streaks. These were of varying sizes (Figure 8). They were mainly in the portal areas but in some places the cells spilled into the sinusoids. The kidneys also showed foci of lymphocytic infiltrations in the interstitium and around blood vessels and glomeruli. Some of these cellular infiltrations appeared as streaks extending from the cortex to the cortico-medullary junction (Figure 9).

The abomasum showed heavy lymphocytic infiltrations in the submucosa. Several lymphoid follicles were also observed.

Figure 7. Section of bone marrow from a calf with lymphosarcoma, showing displacement of the bone marrow (m) by a mass of neoplastic lymphoid tissue (l). H/E ×100.

Figure 8. Section of the liver from a calf with lymphosarcoma, showing foci of lymphocytic infiltrations (l). H/E ×100.
Figure 9. Section of a kidney from a calf with lymphosarcoma, showing foci of lymphocytic infiltration (l) in the interstitium including around the glomeruli (g). H/E ×100.

Besides cellular infiltration, there was oedema between tunica submucosa and tunica muscularis. The heart and intestines had no significant changes.

A review of post mortem records showed that at least four cases of enzootic bovine leukosis have been reported from this herd.

Discussion

Clinically, a diagnosis of juvenile (calf) form of lymphosarcoma was arrived at, on the basis of progressive enlargement of superficial lymph nodes as well as haemonodes. This observation is in agreement with the description of the disease in calves as given by various authors\textsuperscript{1,4,14}. This diagnosis was supported by the presence of many immature lymphocytes and many mitotic figures in the lymph nodes smear.

On postmortem examination, a diagnosis of multicentric form of calf lymphosarcoma was made, due to the involvement of the peripheral and internal lymph nodes as well as kidneys, liver, spleen and bone marrow. This pattern of distribution of lesions together with the presence of increased number of lymphocytes, some of which were immature and others of abnormal morphology in blood, qualifies the present case to be regarded as leukaemic form of lymphosarcoma. It also resembles the multicentric enzootic bovine leukosis in accordance with the descriptions given by various authors\textsuperscript{1,14,15}.

Examination of blood revealed that the calf had normocytic normochromic anaemia similar to that found in adult cattle with enzootic bovine leucosis\textsuperscript{1}. However, an interesting observation, which is rarely reported in the literature, was the presence of immature and abnormal red blood cells and neutrophils in blood. The numbers of these cells (erythrocytes and neutrophils) were also below normal levels. The other types of leukocytes (monocytes, eosinophils and basophils) were not observed in the blood smear. This observation suggests that the displacement of bone marrow by the neoplastic lymphoid cells, not only interferes with the rate of production, but also affects the maturation and
morphology of the other blood cells.

The pattern of distribution of lesions in other tissues such as the lungs, abomasums, and the leptomeninges of the brain in the present case; resembles the multicentric form of lymphosarcoma in adult cattle\(^1\). However, the involvement of the brain beneath the ependyma of the ventricular system (ventricular encephalitis) has not been reported before. The later lesion resembles the non-suppurative ventricular encephalitis encountered in sheep with maedi-visna\(^2\), goats with caprine arthritis-encephalitis (CAE)\(^17,18\) and in pigs with oedema disease\(^20\). Although these diseases in goats, sheep and pigs are considered to be non-neoplastic, they nevertheless show generalized lymphoid hyperplasia and infiltrations of many organs and tissues by both mature and immature lymphocytes\(^16,17,18,19,20\).

Maedi-visna in sheep and CAE in goats are caused by retroviruses of the genus Lentivirus\(^17,21\). It is also known that in adult cattle, the multicentric form of lymphosarcoma (enzootic bovine leucosis) is caused by a retrovirus (oncovirus or bovine leucosis virus-BLV)\(^22\). The present case is of particular interest, because the calf originated from a herd in which EBL has been reported. This suggests that there is a need for further investigations to establish whether there may be a relationship between enzootic bovine leucosis and the calf form of lymphosarcoma.

**Acknowledgements**

The author wish to acknowledge the technical services provided by J.G Mukiri, J.K Mwongi and D.G. Mureithi during the preparation of histopathology slides, and R.N Gitari for photography.

**References**

Amsterdam: 441.


Received for publication on 16th August, 2005
LIVESTOCK AND THEIR ROLE IN MWEA IRRIGATION SCHEME IN KENYA

E. G. KIARIE¹, L.W. KABUAGE²*, G.K. GITAU², J.W. WAKHUNGU² and C.M. MUTERO³.

¹Department of Animal Science, University of Manitoba, Winnipeg, Canada.
²Departments of Animal Production and Clinical Studies, University of Nairobi, Kenya.
³International Water Management Institute (IWMI), Pretoria, South Africa.

LE BETAIL ET SON ROLE DANS LE SYSTEME D’IRRIGATION DE MWEA AU KENYA

Résumé

Une étude a été conduite à l’aide d’une simple analyse statistique, en vue d’évaluer les espèces de bétail et leur rôle dans l’agroécosystème de Mwea, dans le Centre du Kenya. L’étude portait sur deux villages (Ciagini et Mbu-Njeru) situés dans une région où l’on cultive le riz par irrigation et sur deux autres (Kagio et Murinduko) en dehors de la région irriguée, mais situés dans la même zone agro-écologique. Les bovins, les chèvres, les moutons et les poulets locaux étaient les principales espèces animales domestiques élevées. La superficie des terres dont disposait chaque foyer était différente (P<0.05) entre les villages; Ciagini avait la superficie la plus large (5,6 acres), Murinduko (la plus petite avec 0,1 acre), Kagio et Mbu-Njeru avaient une superficie moyenne. Murinduko avait l’UBT (Unité Bétail Tropical) la plus faible (P<0.05) par rapport aux autres villages. Beaucoup plus de foyers dans les villages dotés d’irrigation élevaient des bovins, comparé aux villages non-irrigués (48 contre 38%). En revanche, Les foyers dans les villages qui n’ont pas d’irrigation préféraient élever des petits ruminants (60 contre 15%) et des poulets locaux (80 contre 45%), comparé à ceux des villages dotés d’irrigation. La production animale dans l’agroécosystème de Mwea est à objectifs multiples, à savoir la fourniture de nombreux services et produits pour la subsistance. Cinquante-trois et 59% des propriétaires de bétail dans les villages irrigués et non-irrigués respectivement ont fait savoir que la pénurie alimentaire et les maladies étaient les obstacles majeurs à la production animale. Pour conclure, les éleveurs de bétail dans l’agroécosystème de Mwea préféraient les races locales à cause de leurs aptitudes mixtes et de leur robustesse.

Mots-clés: Agroécosystème de Mwea, bétail, production.

Summary

A study was carried out using a simple statistical analysis to evaluate the kinds and role of livestock in Mwea agro ecosystem, central Kenya. Study area covered two villages (Ciagini and Mbuir-Njeru) in the irrigated rice growing area and another two (Kagio and Murinduko) outside the irrigated area but within the same agro ecological zone. Indigenous cattle, goat, sheep and chicken were the main domestic animal species kept. Land acreage per household differed (P<0.05) between the villages; Ciagini had the highest (5.6), Murinduko the least (0.1) with Kagio and Mbu-Njeru being intermediate. Murinduko had the lowest (P<0.05) tropical livestock units compared to the other villages. More households in the irrigated villages kept cattle compared to non-irrigated villages (48 vs. 38%). In contrast, households in non-irrigated villages preferred small ruminants (60 vs. 15%) and indigenous chicken (80 vs. 45%) compared to irrigated villages. Livestock production in Mwea agroecosystem was multi-faceted with the objective of provision of a variety of services and products for subsistence. Fifty-three and 59% of livestock owners in irrigated and non-irrigated villages respectively reported feed scarcity and diseases as the most important constraints to livestock production. In conclusion, Mwea agroecosystem livestock keepers preferred indigenous breed for multiple utility and hardness.

Keywords: Mwea agroecosystem, livestock, production

*Corresponding author email: Kabuage@gt.co.ke
Introduction

The role of livestock in an agro-ecosystem can be varied and complex. Farmers keep different kinds of livestock and practice different management and production strategies as influenced by the ecological base and varying levels of resources they command. Combining crops and livestock has potential to maintain ecosystem function and health and therefore increase capability to absorb shocks to the natural resource base. By providing draft power, manure and urine as fertiliser, livestock contribute to sustainable, intensive crop production. Furthermore, modest consumption of highly nutritious animal products has a direct impact on human health and productivity.

There is scarcity of information on farming systems research that incorporates animals interactively with cropping systems. To date, research in the animal sciences has too often emphasized component technologies within the disciplines of animal nutrition, health and breeding. Important interactions are known to occur between crops and livestock but data on their benefits and potential environmental risks are limited. Within the Mwea agro-ecosystem in Kenya is a rice based Mwea irrigation scheme (MIS) with annual production of 44,850 metric tonnes or over 80% of national paddy production. The scheme has the potential to produce considerable amount of rice straw and milling by products, for instance Kiarie (unpublished) estimated that one rice crop in MIS yielded over 150,000 tonnes of rice straw. The presence of livestock in MIS had previously been reported. However, the characteristic of livestock keeping system in MIS and therefore the potential for improvement has not been reported in details. Therefore, the objective of the present study was to document the kinds and role of livestock in MIS agro ecosystem.

Materials and methods

Study area

The study was carried out in Mwea division of Kirinyaga district, central Kenya. The division covers about 1,437 square kilometres or 40% of the district. It is located approximately 120Kms North East of Nairobi, lying between 1,090 metres and 1,280 metres above the sea level and consisting of gently rolling plains and isolated hills like Murinduko. The division forms part of Tana River basin which gives rise to Mwea irrigation scheme (MIS). The area is in low midland zone (LM4), which is semi arid with a relatively dry and hot weather most of the year. The rainfall is bimodal with maximum precipitation in April and May (long rains) and minimum precipitation in October and November (short rains), with an annual average of 950mm.

Data collection

On farm survey was carried out in two villages (Ciagini and Mbu Njeru) in MIS and two villages (Kagio and Murinduko) in neighbouring non-irrigated area. A total of 120 farm households were interviewed; 60 in MIS and 60 in neighbouring non-irrigated area. The farm households were selected randomly from lists developed by the demographers. The survey was conducted through the use of a structured questionnaire. Data on household characteristics, kinds of livestock, role of livestock, constraints and opportunities to livestock production were collected.
Table 1: Some descriptive statistics of animal production in Mwea-agroecosystem

<table>
<thead>
<tr>
<th>Species</th>
<th>Irrigated</th>
<th>Non-irrigated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ciagini</td>
<td>Mbui-Njeru</td>
</tr>
<tr>
<td>Calves(^1)</td>
<td>1.6±0.40</td>
<td>1.0±0.00</td>
</tr>
<tr>
<td>Cows</td>
<td>2.2±0.28</td>
<td>1.7±0.16</td>
</tr>
<tr>
<td>Oxen</td>
<td>2.8±0.35</td>
<td>3.0±0.26</td>
</tr>
<tr>
<td>Small ruminants(^2)</td>
<td>3.2±0.75</td>
<td>3.3±1.45</td>
</tr>
<tr>
<td>Indigenous chicken</td>
<td>7.8(^a)±2.02</td>
<td>4.9±0.89</td>
</tr>
<tr>
<td>TLU(^4)</td>
<td>6.6(^a)±0.73</td>
<td>6.0(^a)±0.83</td>
</tr>
<tr>
<td>Land holding in acres</td>
<td>5.6(^a)±0.32</td>
<td>3.4(^a)±0.40</td>
</tr>
</tbody>
</table>

\(^1\)Data except for the land acreage is based on farmers who owned livestock (see Figure 1).
\(^2\)Male or female calf below the age of one year.
\(^3\)Includes sheep and goats.
\(^4\)TLU= Tropical livestock units (1TLU is an equivalent of 250 kgs.) aggregated with the following weights: cows, oxen = 1; calves = 0.5; small stock = 0.25 and poultry 0.05. Different superscripts within the same row indicate significant differences (p<0.05).

Statistical analysis

Collected data sets were entered, managed and analysed using SPSS\(^{11}\). Descriptive statistics generated included counts, frequencies and means. Analysis of variance was used to assess significance differences of means, means with significance F-values were separated by Duncan multiple range test. Chi-square test was used to establish association between variables where applicable\(^{12}\).

Results

General characteristics

The main domestic animal species kept in the Mwea agro ecosystem were the indigenous Small East African Zebu (SEAZ), the Small East African Goat (SEAG), indigenous sheep and indigenous chicken. Land acreage per household differed (P<0.05) between the villages; Ciagini had the highest (5.6), Murinduko the least (0.1) whereas Kagio and Mbui-Njeru were intermediate with similar acreage (Table 1). Murinduko village had the lowest (P<0.05) tropical livestock units (TLU) compared to the other villages. Except for indigenous poultry (P<0.05), the number of livestock owned per household was similar (P>0.05) across all the villages. Murinduko households owned the least numbers of indigenous poultry\(^{5,6}\) and Mbui-Njeru the highest\(^14\), other villages were intermediate. A few households across all the villages raised rabbits, ducks and pigs in small numbers.

Cattle and small ruminants

There was no association, (\(\chi^2=1.22\), P>0.05) between cattle ownership and the location (irrigated or non irrigated areas) of the villages. However, irrigated villages had slightly higher numbers of households (48%) reporting cattle ownership as compared to 38% of households in non-irrigated villages (Figure 1). The Zebu cows in Mwea agro ecosystem
produced milk in small quantities averaging to four litres and one litre per day during early and mid lactation respectively, which translated to an average of 913 litres per annum. The reasons for keeping cattle in the Mwea agro ecosystem were many (Figure 2). No association ($\chi^2=5.835$, P >0.05) was established between the reasons for keeping cattle and the location (irrigated or non-irrigated) of the villages. Eighty and 65% of respondents in non-irrigated and irrigated villages respectively reported milk, bearing young stock, traction, farmyard manure (FYM) and financial security as the main reasons for keeping cattle (Figure 2). Most farmers in non-irrigated villages (58%) used manure on their farms as opposed to those in irrigated areas (43%) who preferred to sell most of their FYM. The main management system of raising cattle in Mwea was extensive/open-grazing method and night confinements in sheds “bomas” near the homestead. Milking was done in the morning. During milking, the cows were provided with rice bran or bean haulms.

There was an association ($\chi^2=25.92$, P<0.05) between the locations (irrigated or non-irrigated) and the percentage of households keeping livestock, as shown in Figure 1.

### Table 2. Some production parameters of Mwea agro-ecosystem indigenous chicken

<table>
<thead>
<tr>
<th>Item</th>
<th>Ciagini</th>
<th>Mbul-Njeru</th>
<th>Kagio</th>
<th>Murinduko</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at onset of laying (months)</td>
<td>10.61±0.51</td>
<td>10.13±0.44</td>
<td>10.64±0.26</td>
<td>10.57±0.27</td>
</tr>
<tr>
<td>Number of clutches per year</td>
<td>2.89±0.20</td>
<td>3.38±0.18</td>
<td>3.52±0.13</td>
<td>2.57±0.16</td>
</tr>
<tr>
<td>Number of eggs per clutch</td>
<td>13.06±1.01</td>
<td>11.88±0.85</td>
<td>16.72±1.14</td>
<td>12.33±0.78</td>
</tr>
</tbody>
</table>

1Based on farmers who owned livestock (see Figure 1)
Table 3: Constraints to livestock production in Mwea agro ecosystem

<table>
<thead>
<tr>
<th>Response (percentage)</th>
<th>Location of the village</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Irrigated area</td>
<td>Non-irrigated area</td>
</tr>
<tr>
<td>Land/feed scarcity</td>
<td>24 (14)</td>
<td>22 (13)</td>
</tr>
<tr>
<td>Capital shortage</td>
<td>2 (1)</td>
<td>7 (4)</td>
</tr>
<tr>
<td>Diseases</td>
<td>3 (2)</td>
<td>3 (2)</td>
</tr>
<tr>
<td>Do not know</td>
<td>10 (6)</td>
<td>9 (5)</td>
</tr>
<tr>
<td>Diseases and land/feed scarcity</td>
<td>53 (31)</td>
<td>59 (35)</td>
</tr>
<tr>
<td>Land scarcity/ feed scarcity</td>
<td>2 (1)</td>
<td>-</td>
</tr>
<tr>
<td>Land/feed scarcity and capital shortages</td>
<td>6 (3)</td>
<td>-</td>
</tr>
</tbody>
</table>

1Based on number of farmers who owned cattle (see Figure 1).
2Reasons for keeping cattle were milking, traction, farmyard manure (FYM) and bearing young stock.
Responses were grouped as single (for households reporting only one reason), double (for household reporting only two reasons) and multiple (for households reporting more than two reasons).

non-irrigated areas) of villages and small ruminant ownership. Sixty percent of households in non-irrigated villages as compared to 15% of households in irrigated villages reported to raise small ruminants (Figure 1). Small ruminants were generally raised for meat, manure, cash income, and for security during times of crop failure. No household reported to be milking goats, although sixty percent of the respondents across all villages suggested that they would support any on farm-trial for introduction of dairy goats. Small ruminants were grazed with cattle during the daytime and housed with cattle at night in the sheds.

Indigenous Chicken
There was an association ($\chi^2=15.68$, $P<0.05$) between indigenous chicken ownership and the location (irrigated or non-irrigated areas) of the villages. Eighty percent of households in non-irrigated villages as compared to 45% of households in irrigated villages reported to keep indigenous chicken (Figure 1). The average age for the onset of laying was 11 months and the number of clutches per chicken was 3 with an average of 14 eggs per clutch (Table 2). Eighty percent of the households reported to raise their chicken through scavenging with some supplementation, where they free ranged during daytime and confined in the kitchen or main house at night. The birds’ fed around the homestead on waste paddy, grass, food waste and insects. Chicken meat and eggs were a delicacy and were frequently consumed at home and sold when in excess.

Constraints to livestock production
No association ($\chi^2=6.162$, $P>0.05$) was established between the constraints to livestock production and the locations (irrigated or non-irrigated) of the villages. Over 50% of the farmers reported diseases and feed scarcity as the major limiting factors to livestock production (Table 3).
Discussion

The preference for indigenous livestock breeds in Mwea despite their low productivity could be linked to the prevailing agro ecological conditions. The feed base (land), ambient temperatures and the disease challenge to a large extent govern the development of potential livestock production systems. Mwea is in low midland zone (LMZ), which is semi arid with a relatively dry and hot weather most of the year. Lack of alternative breeds and tolerance to local diseases has also been reported to influence preference to indigenous breeds in semi-arid areas of Kenya.

Presence of more cattle in irrigated villages may be associated with the availability of large quantities of rice crop residues and utility as draught animals in paddy fields. Similarly, studies in rice growing areas in South East Asia reported preference for large ruminants (cattle and water buffaloes) were heavily concentrated in the rice growing lowlands where their value was mainly for draught and haulage. In agreement with Preston and Leng rearing large ruminants required more land as demonstrated by higher TLU in Ciagini (irrigated) with the highest acreage and the lowest TLU in Murinduko (non-irrigated) with the smallest acreage. However, lack of an association between cattle ownership and location of villages (irrigated vs. non-irrigated) in the present study suggests that other factors may influence cattle ownership in MIS agro-ecosystem. One such factor is the possibility that the rice straw after rice harvest becomes a communal resource accessible to cattle from irrigated and surrounding non-irrigated villages. Implication of communal utility of rice by products and
sale of manure is that there is net export of nutrients from irrigated paddies a phenomenon well described by Powell and William. However, the complexity of the role of livestock in MIS agro-ecosystem becomes clearer when small ruminant ownership is taken into account. Thus, based on the current data it appears that small ruminants ownership in non-irrigated villages is commensurate to the resource base in their command. In this context, it can be speculated that cattle ownership in the surrounding non-irrigated areas is influenced by availability of rice by products in MIS and possibly commercial provision of traction in paddies. Subsequently, an evaluation of rice straw utilization based on cattle ownership in MIS without due considerations to the whole ecosystem may be an under estimation.

The South East Asian studies also reported a high concentration of poultry and ducks in the irrigated lowlands, which utilised post harvest losses of rice to a greater advantage. These observations disagreed with the present study where more farmers in the non-irrigated than irrigated villages kept indigenous chicken and only one farmer reported to own ducks in MIS. This suggested that a considerable amount of feed that has potential to support diverse poultry populations was lost in every rice-harvesting season. In general, livestock in Mwea were raised for multiple reasons. Two main categories of livestock keepers in an African context; have been identified those whose main objective is purely commercial and those whose main objective is the provision of a variety of services and products for subsistence. Mwea farmers fell into the later category. The type of livestock production system in Mwea is close to the semi intensive livestock production system where livestock especially cattle play diverse roles. Nevertheless, although livestock is secondary to rice in MIS, rice growing is seasonally labour intensive and farmers would find it imperative to raise livestock to complement incomes from cropping activities.

Livestock in Mwea faces multiple constraints, the major ones being feed scarcity and diseases. Such constraints are associated with many and varied factors under smallholder production systems. It is rather surprising that feed scarcity is a major livestock production constraint in MIS given the large quantity of rice by products. This aspect may require further investigation to understand how the resource was utilized.

The major constraints to livestock observed in the present study are consistent with small land size and unfavorable climatic conditions. Mwea farmers lack enough land for growing highly nutritious fodder crops and animals depends on poor quality crop residues such as rice straw as well as grazing along canals and roadsides. Of particular interest in Mwea agro-ecosystem is the fact that irrigation has been strongly associated with malaria prevalence in the area. In this context, Mutero et al. suggested that if cattle were integrated in a properly managed Mwea agro-ecosystem, prevalence for malaria would dramatically reduce, if for instance cattle would act as diversionary blood-meal hosts for mosquitoes a concept known as zooprophylaxis.

In conclusion livestock in Mwea agro-ecosystem are of indigenous type, low productivity and are kept for multiple utility. Diseases and feed scarcity were the major constraints to their production. Although indigenous livestock are suited for survival
under the prevailing climatic conditions in Mwea, productivity would significantly improve if appropriate intervention measures were put in place across the entire husbandry spectrum of breeds, feeding, disease control and general management. In particular, means to harness enormous quantity of nutrients and energy embodied in the mass of rice by products for the benefit of MIS livestock need to be urgently developed.

Acknowledgements

The international Development Research Centre (IDRC) through the Ecosystem Approaches to Human Health program initiative supported this research (centre File: 100482). E. Kiarie was in receipt of University of Nairobi, board of postgraduate study scholarship. Acknowledgments are also extended to Mwea farmers who enthusiastically participated in this study.

References

11. SPSS (Statistical Package for social sciences) version 10.0, 1999, New Jersey, USA.

Received for publication on 14th July, 2004
THE USE OF BOVINE COLOSTRUM AS A SOURCE OF IMMUNOGLOBULIN (lg) FOR LAMBS

R. L. GLOVER¹, E.K. AWOTWI²*, B. AWUMBILA² and K. OPPONG-ANANE³,

²Department of Animal Science, University of Ghana, Legon, Ghana.
³Animal Production Directorate, Ministry of Food and Agriculture, Accra, Ghana.

UTILISATION DU COLOSTRUM BOVIN COMME SOURCE D’IMMUNOGLOBULINE (lg) POUR LES AGNEAUX

Résumé

On a mené une étude sur l’utilisation du colostrum bovin comme autre source d’immunoglobuline pour les agneaux, au Centre de recherche agricole (Legon) de l’Université du Ghana. L’étude portait sur un total de 56 agneaux. Trente-trois d’entre eux étaient allaités au biberon avec du colostrum bovin décongelé, tandis que le reste (23) pouvait téter leurs mères et servait de sujets-témoins. Les concentrations moyennes de l’immunoglobine (lg) dans le sérum des deux groupes d’agneaux étaient déterminées à 6 heures d’intervalles pendant les premières 48 heures après l’agnelage, à l’aide d’un réfractomètre de poche. Il n’y avait pas de différence significative (P>0,05) quant aux niveaux d’lg entre les agneaux nourris de colostrum (21,01 unités zst et les agneaux qui têtaient normalement (18,26 unités zst). Le niveau maximum d’lg dans le sérum pour les agneaux nourris de colostrum bovin s’est produit 12 heures après l’agnelage contre 24 heures pour les agneaux qui têtaient normalement. Les types de croissance pour les deux groupes d’agneaux étaient similaires. Il a été conclu que le colostrum bovin peut être utilisé comme autre source efficace d’lg pour les agneaux.

Summary

A study on the use of bovine colostrum as an alternative source of immunoglobulin for lambs was carried out at the University of Ghana’s Agricultural Research Centre (Legon). The study involved a total of fifty-six lambs. Thirty-three of them were bottle-fed with frozen-thawed bovine colostrum while the rest (twenty-three) were allowed to suckle their dams and served as the control. The mean serum immunoglobulin (lg) concentrations of both groups of lambs were determined at 6hr intervals during the first 48 hrs of life, using a pocket refractometer. There was no significant difference (P>0.05) in lg levels between the bovine colostrum-fed lambs (21.01 zst units) and the normally suckled lambs (18.26 zst units). The peak serum Ig level for the bovine colostrum-fed lambs occurred at 12hrs postpartum as against 24hrs for the normally suckled lambs. The growth patterns for both groups of lambs were similar. It was concluded that bovine colostrum could be used as an effective alternative source of Ig for lambs.
Introduction

Sheep and goats are preferable to cattle in marginal areas chiefly because of their lower absolute nutrient requirements, better selective grazing ability, broader fodder consumption spectrum and better utilization of less widely available by-products and waste products in all ecological zones. One aspect of small ruminant production that has militated against the industry is the distressingly high neonatal mortality. In Ghana, for example, neonatal mortality rates of 20% and 52.9% have been reported for kids and lambs respectively.

The survival of the neonate initially depends on passive maternal immunoglobulin (Ig) transfer to the newborn animals via colostrum. To acquire initial immunity, the neonate must nurse and absorb the essential immunoglobulins provided in colostrum, or first milk. In almost all instances, passive immunity in neonates is quantified by the concentration of immunoglobulin G (IgG) formed in the blood stream at 24 to 48 hours after birth. Indeed, the incidence of neonatal diseases has been found to be positively associated with low serum immunoglobulin (Ig) concentrations in the newborn. Availability of alternative sources of high quality colostrum is important for circumventing colostral deficiencies. Alternative Ig sources have been developed commercially and may be used to fortify or replace natural colostrum. Commercially available colostral supplements, however, are less efficient in providing immunoglobulin transfer and disease protection to calves, compared to natural colostrum, even if fed equal volume and similar concentration. It has been shown that piglets absorb IgG from bovine colostrum in the same manner as swine IgG, but bovine IgG failed to regulate the level of synthesized immunoglobulins.

Since small ruminants often bear more than one offspring which they are not capable of nursing effectively, lambs born as triplets or quadruplets have lower chances of survival than twins or singles. Inadequate intake of colostrum may occur as a result of the death of a dam or failure of an ewe to lactate normally. Occasionally, there may also be the desertion of lambs by their dams. This study therefore sought to evaluate the effect of using frozen-thawed bovine colostrum as a source of immunoglobulin for lambs.

Materials and Methods

The study was carried out at the University of Ghana’s Agricultural Research Centre (ARC, Legon). Bovine Colostrum which was used for the experiments was collected from the Ministry of Food and Agriculture’s Dairy Research Station (Amrahia).

Mammary secretions were collected from several multiparous cows by hand stripping of the mammary glands from zero through 15 hrs after parturition when there was free flow of colostrum. Samples were bulked and mixed thoroughly to provide a single source of natural colostrum. The pool of colostrum was then divided into aliquots and placed in plastic freezer bags and stored frozen at $-4^\circ$C for later use. Data were collected from fifty-six lambs; twenty-three of which were allowed to suckle their dams whilst the rest were bottle-fed with frozen-thawed warm bovine colostrum. To prevent the rejection of lambs by their dams, the bovine colostrum-fed lambs were kept with their dams in the same pen. However, to prevent the lambs from suckling, they were placed in open
top cages. Even though the dams had access to their lambs through the top of the cage, they could not suck them. At the time of feeding, the frozen colostrum was thawed by placing it in warm water at 45°C. The first feeding was done within the first 1 hr after birth. Subsequently lambs were fed at 6 hours intervals till 48 hrs after birth. They were then released from their cages and allowed to suckle their dams. Blood samples were collected from both groups of lambs soon after birth and prior to initial feeding of colostrum. Thereafter samples were collected at six hours intervals till 48 hrs after birth. Each sample

Table 1: Mean and peak Immunoglobulin (Ig) concentrations in normally suckled and bovine colostrum-fed lambs during the first 48hrs of life.

<table>
<thead>
<tr>
<th>Group</th>
<th>No</th>
<th>Mean Serum Ig (zst)</th>
<th>Peak Serum Ig (zst)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSL</td>
<td>23</td>
<td>21.01±1.04a</td>
<td>28.5±1.59a</td>
</tr>
<tr>
<td>BCF</td>
<td>33</td>
<td>18.26±0.95a</td>
<td>24.5±1.33b</td>
</tr>
</tbody>
</table>

NSL - Normally suckled lambs  
BCF - Bovine colostrum-fed lambs

*Means in columns with different superscripts are significantly different.

Figure 1: Serum Immunoglobulin concentration in normally suckled lambs and lambs bottle-fed with bovine colostrum for 48 hrs of life

NCL - Normally suckled lambs  
BCL - Bovine Colostrum-fed lambs
was centrifuged at 2000 revolutions per minute for 10 minutes to obtain the serum. A pocket refractometer (Bellingham and Stanley Ltd. Model L10) was used to estimate the concentration of immunoglobulins in Zinc Sulphate Turbidity (zst) units. The refractometer works on the principle that the refractive index of a solution is determined by its concentration. Graphs of refractometer readings and age of lambs were plotted for the two groups of lambs and from this the period of peak immunoglobulin absorption from ingested colostrum determined. All lambs were weighed daily for the first week and thereafter on days 14, 21 and 42 post partum.

**Statistical analysis**

The Ig values of serum from the two experimental groups (normally suckled and bovine colostrum-fed) were presented as means and plotted against time. Comparisons between groups of lambs were performed for serum Ig concentrations, weaning weight and mortality. The data was subjected to analysis of variance (ANOVA) using a computer based statistical programme (Gemstat). Comparisons were made at 5% level of significance or otherwise indicated. When significant differences were found, means were separated using LSD.

**Results**

The mean serum Ig concentration of normally suckled lambs and lambs artificially fed with bovine colostrum are shown in Figure 1. The two groups of lambs had insignificant levels of immunoglobulin before their first suck. The serum Ig levels for normally suckled lambs increased gradually and reached a peak at

**Figure 2:** Pre-weaning growth (kg) of normally suckled lambs and those bottle-fed with bovine colostrum for the first 48 hrs of life

- **NSL** – Normally suckled lambs
- **BCF** – Bovine Colostrum-fed lambs
24 hrs following the ingestion of colostrum and then gradually declined. The serum Ig level for lambs fed bovine colostrum peaked at 12 hrs and thereafter declined. Analysis of variance revealed no significant differences (P<0.05) in serum Ig concentration between lambs belonging to the two colostral treatment groups (Table 1). The peak serum Ig concentration for the normally suckled lambs was significantly higher (P<0.05) than that of the bovine colostrum-fed lambs.

There was also no significant difference (P<0.05) in the growth pattern of the two groups of lambs (Figure 2). Four out of the 33 lambs fed bovine colostrum and two of the 23 normally suckled lambs died during the first week of life. All the 6 lambs that died had Ig levels that were comparable to those that survived in both the normally suckled and bovine colostrum-fed groups.

Discussion

The results from the present study showed that neither the normally suckled lambs nor the bovine colostrum fed ones had any measurable quantities of serum immunoglobulin before their first suck. This shows that lambs, like other neonates with epitheliochorial placentation, have no antibodies from their dam before birth and need to ingestcolostrum to provide passive immunity. The results of the study also showed that both groups of lambs had appreciable mean serum immunoglobulin levels after colostrum ingestion (21.0 and 18.3 zst units for normally suckled and bovine colostrum-fed lambs respectively). This is an indication that the heterologous immunoglobulin of the bovine colostrum was absorbed with the same similarity as the homologous immunoglobulin of the ovine colostrum. This confirms the findings of other workers\textsuperscript{11,12}. The slightly lower mean serum immunoglobulin level observed in the bovine colostrum-fed animals is also consistent with findings by other workers\textsuperscript{13,14}. The better efficiency of apparent absorption of Ig by calves allowed to suckle their dam has been attributed to neural effects of the presence of the dam. The results of the present study showed clearly that whilst the serum immunoglobulin level for the bovine colostrum-fed lambs peaked at 12 hrs, that for the normally suckled lambs peaked at 24 hrs. This indicates that the absorption of heterologous immunoglobulin from the alimentary tract ceases earlier than the absorption of homologous immunoglobulin. This suggests that if lambs have to be fed bovine colostrum, adequate amounts must be fed as early as possible since absorption of immunoglobulin could decrease markedly after only 12 hrs. There were no significant differences in the pattern of growth and mortality rates in the two groups of lambs; an indication that bovine colostrum is effective in offering protection to lambs.

The results of this study would be useful particularly to sheep and goat keepers in peri-urban areas where there is accessibility to electricity and where large herds of cattle are kept and therefore bovine colostrum readily available.

References


Received for publication on 15th March, 2006
APPLICATION OF MICROAGGLUTINATION TEST FOR DETECTION OF ANTIBODIES TO SALMONELLA GALLINARUM IN COMMERCIAL LAYER CHICKENS

P. N. WAMBURA1*, H. G. MAKURI2, A. S. HOZA1, H. TUNTUFYE1 and L. S. B. MELLAU3

1Department of Veterinary Microbiology and Parasitology, Faculty of Veterinary Medicine, Sokoine University of Agriculture, P. O. Box 3019, Morogoro, Tanzania.

2Faculty of Science, Technology and Environmental Studies, The Open University of Tanzania, P. O. Box 23409, Dar Es Salaam, Tanzania

3Department of Veterinary Medicine and Public Health, Faculty of Veterinary Medicine, Sokoine University of Agriculture, P. O. Box 3201, Morogoro, Tanzania.

APPLICATION DU TEST DE MICROAGGLUTINATION POUR LA DETECTION DES ANTICORPS A SALMONELLA GALLINARUM CHEZ LES PONDEUSES COMMERCIALES

Résumé
Dans cette étude, un test de microagglutination (MAT) a été mis au point, évalué et comparé au test d’agglutination rapide effectué à partir du sang entier (RWBAT) pour la détection de Salmonella gallinarum chez les pondesuses commerciales à Morogoro en Tanzanie. Les résultats ont montré qu’à la ferme de Kigurunyembe, 16 (32%) des poulets testés étaient positifs pour RWBAT, tandis que 30 (60%) étaient positifs pour MAT parmi les 50 sérums testés. Les résultats obtenus à la ferme de Kilakala ont révélé que 10 sérums (20%) étaient positifs pour RWBAT, alors que 5 (10%) étaient positifs pour MAT parmi les 50 sérums testés. Dans les deux fermes, S. gallinarum était isolé de 21 poulets. Les valeurs de sensibilité, de spécificité, de prévision de cas positifs et négatifs pour MAT étaient de 57, 71, 34 et 86% respectivement ; et 67, 85, 54 et 82% respectivement pour RWBAT. Même si MAT était légèrement moins sensible et moins spécifique que RWBAT, il laissait apparaître une séroprévalence plus forte (35%) de typhoïde aviaire que RWBAT (26%). Le test s’est avéré mieux lorsqu’il est optimisé, parce qu’il nécessite moins de temps, d’espace et d’antigène ; il permet, par ailleurs, de faire une évaluation objective des titres d’anticorps. Une plus forte séroprévalence et croissance (en milieu de culture) de S. gallinarum a été constatée chez les poulets « Rhode Island Red » que chez les « Black Australorp ».

Mots-clés: Poulets, Test de microagglutination, Salmonella gallinarum, séroprévalence, Test d’agglutination effectué à partir du sang entier.

Summary
In this study a microagglutination test (MAT) was developed, evaluated and compared with a rapid whole-blood agglutination test (RWBAT) for detection of Salmonella gallinarum antibodies in commercial layer chickens in Morogoro, Tanzania. The results showed that at Kigurunyembe farm, 16 (32%) of chicken tested were RWBAT positive while 30 (60%) were MAT positive among the 50 sera tested. Results from Kilakala farm revealed 10 (20%) sera that were RWBAT positive whereas 5 (10%) were positive.

*Corresponding Author
positive for MAT among the 50 sera tested. On both farms, S. gallinarum was isolated from 21 chickens. The sensitivities, specificities, positive and negative predictive values for MAT were 57, 71, 34 and 86%, respectively, and 67, 85, 54 and 82%, respectively for RWBAT. Although MAT was slightly less sensitive and less specific than RWBAT, it revealed a higher true seroprevalence (35%) of fowl typhoid than RWBAT (26%). When the test is optimized it may be preferred because it uses less time, space and antigen while permitting more objective evaluation of antibody titers. Higher growth and seroprevalence of S. gallinarum was observed in Rhode Island Red than Black Australop chickens.

Key words: Chickens, Microagglutination test, Salmonella gallinarum, Seroprevalence, Whole blood agglutination test.

Introduction

Fowl typhoid (FT) is a disease of poultry caused by Salmonella enterica subspecies enterica serovar Gallinarum biovar gallinarum (Salmonella gallinarum)\(^1\). It is a gram-negative bacterial rod, which belongs to the family Enterobacteriaceae (Serogroup D). The bacterium is transmitted by both respiratory and oral routes (horizontal). Birds may become carriers and pass the organism to their offspring by egg transmission (vertical)\(^2\).

Fowl typhoid is one of the most important disease affecting chickens in Tanzania\(^3\). Birds of all ages and both sexes are susceptible to infection, but the serious losses occur in laying hens and pullets coming into lay. The mortality rate in a susceptible flock may reach 80%\(^4\). Minga and Kikopa\(^3\) reported that FT is endemic in Tanzania and that S. gallinarum accounted for 68% of all Salmonella isolations made from 1968 to 1982. Study by Mdegela et al\(^5\) indicated that FT is still endemic in Tanzania and S. gallinarum infection is more prevalent in commercial layer than scavenging local chickens.

The disease can be unequivocally diagnosed by the isolation of S. gallinarum from affected birds\(^6\). However cultivation and isolation of this organism is not always fruitful especially when cloacal swabs are used as a source of faecal samples from acutely sick or recovered birds\(^7\). In these cases serological tests may be recommended for routine diagnosis and surveillance of FT.

Serological tests are best applied as flock tests as the results of individual birds may vary according to the stage of infection\(^8\). The tests which are the most commonly used are rapid whole-blood agglutination test (RWBAT), rapid serum agglutination (RSA), tube agglutination (TA) and microagglutination test (MAT)\(^8\). The RWBAT may be used in the field for detecting both S. gallinarum and S. pullorum, and the results read immediately. Chickens can be tested at any age, although it is recommended to test them at a minimum age of 4 months (13-14 weeks) to avoid interference with maternal antibodies in chicks\(^8\). Other serological tests include microantiglobulin, immunodiffusion, haemagglutination and enzyme linked immunosorbent assays (ELISA)\(^9,10\).

Studies on febrile infections (Brucella abortus, S. Thompson and S. pullorum)\(^11,12\) other than S. gallinarum infection have shown that MAT is more sensitive and spe-
specific than others, moreover, it uses small amount of antigen, easier to read and requires less time to perform than the TA test. MAT has been reported to be a reliable procedure, economical in time and equipment\textsuperscript{11}.

Traditionally \textit{S. pullorum} antigens are used for identification of fowls infected with \textit{S. gallinarum}. But it is possible that they may be slightly antigenically different\textsuperscript{13}. Moreover \textit{S. gallinarum} antigen react only to \textit{S. gallinarum} antibody but not with \textit{S. pullorum} antibody thus it is more specific for FT.

The objective of the present study was therefore to develop, evaluate and compare MAT with RWBAT for detection of \textit{S. gallinarum} antibodies in naturally infected commercial layer chickens.

**Materials and methods**

**Study area**

The study was conducted at Kigurunyembe and Kilakala farms that are located in the eastern suburbs of Morogoro municipality, 2 kilometers apart.

**Management of chickens**

Both farms had similar chicken management systems. Chickens were kept on deep litter. They were fed chicken layer mash according to manufacturer's instructions and water was available \textit{ad libitum}.

**Sampling procedures**

Kigurunyembe farm had 3 flock units; comprised of 200, 200 and 100 commercial layer chickens, respectively. Samples were randomly collected from each flock whereby 20 blood samples and 20 cloacal swabs were collected from flocks 1 and 2, but only 10 blood samples and 10 cloacal swabs were collected from flock 3. Flocks 1 and 2 had Rhode Island Red chickens, whereas flock 3 had Black Australop chickens. Kilakala farm hand only one flock with 130 Black Australop chickens from which 50 blood samples and 50 cloacal swabs were collected randomly. Two samples (blood samples and cloacal swabs) were collected from each bird selected for sampling.

**Cloacal swab collection, isolation and identification of \textit{S. gallinarum}**

Cloacal swabs were collected using sterile cotton wool swabs. Swabs were placed in universal bottles containing 10 ml of Selenite F broth in the field. The bottles were stored in a cooler box with ice packs until they reached the laboratory where they were incubated at 37\textdegree C for 24 hours thereafter subcultured onto brilliant green agar (BGA) and incubated at 37\textdegree C overnight. Red colonies (non-lactose fermenters) were subcultured again on BGA for purification. Pure non-lactose fermenting colonies were characterized as described by Mdegela et al\textsuperscript{6}.

**Blood sample collection and serum preparation**

From each chicken blood sample (2 ml) was aseptically collected from the wing vein by using a 21-gauge sterile needle and a 2.5 ml syringe, and about 30-\mu l fresh blood was used immediately for the RWBAT. The remaining blood sample was kept in slanted position in a cooler box for up to 12 hours, after which serum was harvested by decanting. The harvested sera were transferred into
1.5 ml micro-centrifuge tube and stored at -20° C until used for MAT.

**Antigen preparation and serological tests**

The antigen used for MAT and RWBAT was locally produced as described in the Manual of Standards for Diagnostic Tests and Vaccines for Terrestrial Animals\(^8\) using a local *S. gallinarum* strain. The two tests were performed according to procedures described by OIE\(^8\).

**Statistical analysis**

Contingency tables were formed with the data measured by the MAT and the RWBAT, using culture as reference standard test. The analytical software programme Epi Info for Windows version 3.2.2 was used for data analysis\(^14\). The Chi-square test was used for the difference between two independent proportions. The prevalence ratios for detection of strength of association were calculated according to Martin *et al*\(^15\). Diagnostic values (specificity and sensitivity), positive and negative predictive values and true prevalence were calculated using WIN EPISODE 2.0 improved serological software for veterinary medicine\(^16\).

**Results**

Culture and serological results are summarized in Tables 1 and 2. At Kigurunyembe farm 16 out of 50 commercial layer chickens were positive to *S. gallinarum* antibody when using RWBAT. In contrast when MAT was used, 30 out of 50 chickens were seropositive in the same farm. Moreover the difference of the results from the two tests was statistically significant (p<0.001). Results from Kilakala farm showed that 10 out of 50 commercial layer chickens were seropositive for *S. gallinarum* by using RWBAT. When MAT was used 5 out of 50 chickens were seropositive for *S. gallinarum* antibody. This difference was not statistically significant (p>0.05).

At Kilakala farm *S. gallinarum* was isolated from 14 chickens whereas in Kigurunyembe farm the bacterium was isolated from 7 chickens. *S. gallinarum* was isolated from a total of 21 chickens; this number of chickens was lower than what was recorded in serological tests results (Table 1).

**Table 1:** Serological and cultural prevalence of *S. gallinarum* infection in commercial layer chickens

<table>
<thead>
<tr>
<th>Serological tests</th>
<th>Whole blood</th>
<th>Microagglutination</th>
<th>Cloacal swab cultures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm</td>
<td>n</td>
<td>Seropositive</td>
<td>Seropositive</td>
</tr>
<tr>
<td>Kigurunyembe</td>
<td>50</td>
<td>16 (32%)</td>
<td>30 (60%)</td>
</tr>
<tr>
<td>Kilakala</td>
<td>50</td>
<td>10 (20%)</td>
<td>5 (10%)</td>
</tr>
</tbody>
</table>
Table 2: Diagnostic values of two serological tests for S. gallinarum

<table>
<thead>
<tr>
<th>Test</th>
<th>No. of results</th>
<th></th>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV&lt;sup&gt;a&lt;/sup&gt;</th>
<th>NPV&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>True positive</td>
<td>False positive</td>
<td>True negative</td>
<td>False negative</td>
<td>(%)</td>
<td>(%)</td>
<td>(%)</td>
</tr>
<tr>
<td>Microagglutination</td>
<td>12</td>
<td>23</td>
<td>56</td>
<td>9</td>
<td>57</td>
<td>71</td>
<td>34</td>
</tr>
<tr>
<td>Rapid whole blood agglutination</td>
<td>14</td>
<td>12</td>
<td>67</td>
<td>7</td>
<td>67</td>
<td>85</td>
<td>54</td>
</tr>
</tbody>
</table>

<sup>a</sup>PPV, positive predictive value
<sup>b</sup>NPV, negative predictive value

Table 3: Chicken breed predisposition to S. gallinarum infection

<table>
<thead>
<tr>
<th>Breed</th>
<th>Serological tests</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Whole blood</td>
<td>Microagglutination</td>
<td>Cloacal swab cultures</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seropositive</td>
<td>Seropositive</td>
<td>Culture positive</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhode Island red</td>
<td>40</td>
<td>14 (35%)</td>
<td>27 (67.5%)</td>
<td>12 (30%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black Australop</td>
<td>60</td>
<td>12 (20%)</td>
<td>8 (13.3%)</td>
<td>9 (15%)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The true prevalence of S. gallinarum was 35% by MAT whereas RWBAT recorded 26%. The sensitivities, specificities, and positive and negative predictive values were 57, 71, 34 and 86%, respectively, for MAT and 67, 85, 54 and 82%, respectively for RWBAT. These results showed that RWBAT had higher diagnostic values than MAT, however, the difference was not statistically significant (p>0.05) (Table 2).

It is worth noting that Rhode Island Red chickens had statistically significant higher (p<0.001) cultural and seroprevalence of S. gallinarum infection than Black Australop chickens (Table 3).

Discussion

Previous studies conducted in Tanzania<sup>17,18</sup> reported serological prevalence of FT in commercial layer chickens. The findings of the present study confirm that FT still occurs in Tanzania and therefore appropriate control measures should be instituted<sup>1</sup>.

In the present study seropositive individuals exceeded the number of chickens from which bacteria were isolated. Similar findings were reported in the past<sup>17,18,19</sup>.

In the present study it was observed that Rhode Island Red chickens were more frequently affected by S. gallinarum infec-
tion than Black Australops. These results agree with a past study reported genetic resistance to FT in lines of White Leghorn chickens\textsuperscript{20}. Moreover, it reported that among the commercial breeds studied, Lohman (Holland) was the most resistant to \textit{S. gallinarum} infection\textsuperscript{21}.

There is no single test for \textit{Salmonella} which is appropriate in each and all-epidemiological situations; all have limitations especially when it comes to screening of individual animals\textsuperscript{8}. It has been shown that rapid plate agglutination test was more sensitive than SAT\textsuperscript{18}. In the present study MAT was more sensitive than RWBAT at one farm but not the other. The reason probably is that in the second farm the prevalence of FT was lower than in the first farm.

Microagglutination technique was reported to be more reliable, less time and antigen consuming and permitted a more objective evaluation of agglutinin titers of \textit{salmonella} infection than WBRAT because the former is a quantitative test and the latter is a qualitative test\textsuperscript{22}.

In another study MAT was found not significantly different for the detection of pullorum infection and was followed in efficacy by the RSA, TA, swab tests in that order\textsuperscript{12}.

Although in the present study MAT was less sensitive than RWBAT, MAT had a true prevalence of 35% whereas that for RWBAT was 26%. The two tests had similar positive predictive values and specificity. A diagnostic test with high specificity is preferred if false positive results could have a large effect, for example, when test positive animals would be slaughtered. In this case both tests would be recommended.

The choice of a test does not only depend on test specific parameters but also aspects like costs, practicability, easy of handling, and possibility of automation\textsuperscript{12}. In this regard MAT may be a preferred test.

From the findings of the present study, it has been shown that use of either RWBAT or MAT may be adequate for screening of FT for Tanzanian situation. This is the first report where MAT has been used for screening of \textit{S. gallinarum} infection in Tanzania; however, optimization of this test would be required.

**Acknowledgements**

The excellent technical assistance provided by Messrs. M. Shoo, M. Mugusi and G. Mulungu during the present study is highly acknowledged.

**References**

Application of microagglutination test for detection of antibodies to *Salmonella gallinarum* in commercial layer chickens.


Received for publication on 27th September, 2005
The excellent technical assistance provided by the following individuals is gratefully acknowledged:

A. Mubangya during the present study and M. Magdel also from the above laboratory.

References

EXPERIMENTAL TRIALS WITH V₄ HR AND LASOTA NEWCASTLE DISEASE VIRUS VACCINES ADMINISTERED TO CHICKS VIA EYE DROP, DRINKING WATER AND COMMERCIAL FEED

J.A. NWANTA¹, J.U. UMOH², P.A. ABDU² and I. AJOGI²

¹Department of Veterinary Public Health and Preventive, Medicine University Nuskka, Nigeria.

²Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria, Nigeria

ESSAIS EXPERIMENTAUX AVEC DES VACCINS V₄ HR ET LaSota CONTRE LE VIRUS DE LA MALADIE DE NEWCASTLE ADMINISTRES A L’AIDE DES GOUTTES POUR LES YEUX, DE L’EAU POTABLE ET DES ALIMENTS COMMERCIAUX

Résumé

Des jeunes poules Black Harco étaient vaccinées à l’âge de 5 semaines avec un vaccin malaisien V4HR (V₄) ou un vaccin nigerian LaSota (LaSota) administré à l’aide des gouttes pour les yeux (GY), de l’eau potable (EP) ou des aliments commerciaux (AC). Les niveaux d’ anticorps dans leurs sérum étaient déterminés avec le test d’inhibition de l’hémagglutination (TIH) à une semaine d’intervalles pendant 5 semaines. On a aussi déterminé la corrélation entre le titre d’ anticorps contre le virus de la maladie de Newcastle (VMN) obtenu avec les deux vaccins administrés à l’aide des trois voies. La protection contre la mortalité a été évaluée suite à l’infection par une souche virulente 33/56 de Hert de VMN à l’âge de 7 semaines.

La réaction immunitaire et la protection étaient nettement mieux (P<0,05) chez les jeunes poules vaccinées avec V₄ par rapport à celles vaccinées avec LaSota et ce, indépendamment de la voie d’administration du vaccin. GY était meilleure que EP et AC ; en revanche, la réaction immunitaire n’était pas différente (P>0,05) de celle de EP. Les jeunes poules vaccinées avec V₄ par voie AC étaient mieux protégées (62,50%) que celles vaccinées avec LaSota par voie AC (11,10%). Il a été conclu que V₄ était plus immunogène et protégeait mieux que LaSota, et que GY était la meilleure voie d’administration de V₄, qui pouvait protéger 62,50% des jeunes poules vaccinées à l’aide de AC.

Mot-clés: Goutte pour les yeux, aliments, LaSota, maladie de Newcastle, V₄, eau.

Summary

Black Harco pullets were vaccinated at 5 weeks of age with a Malaysian V₄ HR (V₄) or Nigerian LaSota (LaSota) vaccine administered via eye drop (ED), drinking water (DW) or commercial feed (FD) and the antibody (Ab) levels in their sera were determined using haemagglutination inhibition test (HIT) at weekly intervals for 5 weeks (Wk). Determined also was the correlation between the Newcastle disease virus (NDV) Ab titre achieved with the two vaccines administered via the three routes. Protection from death following challenge with a virulent NDV Hert’s 33/56 strain at 7 weeks of age was assessed.

Immune response and protection was significantly better (P<0,05) in birds vaccinated with V₄ compared to those vaccinated with LaSota irrespective of route of administration. ED was better than DW and FD but the immune response was not (P>0,05) different from that of DW. Birds vaccinated with V₄ in FD were better protected (62.5%) than those vaccinated with LaSota in FD (11.1%). It was concluded that V₄ was more immunogenic and protective than LaSota and ED was the best route of administration of V₄, which was capable of protecting 62.5% of the birds vaccinated via commercial FD.

Key words: Eye drop, feed, LaSota, Newcastle disease, V₄, water

*Corresponding Author: Email: cjonz@yahoo.com
Introduction

Newcastle disease is often a fatal viral disease that affects a wide range of avian hosts, irrespective of age and sex. In Africa and Asia, ND is reported to be a major constraint to the development of the village poultry industry. It causes loss in egg and meat production as a result of mortality and reduced weight gain.

In Nigeria, ND is controlled by vaccination with live vaccines. This conventional vaccination in commercial chickens is often effective as the flocks are large and of the same age and vaccines can be kept at low temperatures to the point of delivery. The vaccines are sophisticated and produced in large dose formats. The use of these vaccines in village chickens is limited by cost, dose format and lack of thermostability. Because of these reasons, rural scavenging chickens are rarely vaccinated and flocks remain highly susceptible to ND with periodic decimation and economic losses.

In view of these losses, indications are that local poultry farmers would welcome any new technology aimed at controlling the disease.

Reports have shown that V vaccine is available for use in village chickens worldwide and its use has yielded encouraging results in Cameroon, Ghana, South Africa and Tanzania, Zambia and Southeast Asia. The Australian Centre for International Agricultural Research (ACIAR) has commissioned scientists at the Virus Laboratory in the University of Queensland to produce a seed virus similar to V that could be available without cost to laboratories in several countries and the vaccine has proved to be protective against local virulent strains of NDV. In Vietnam, Tanzania and Mozambique has been recognized as the vaccine for ND control in village chickens. This vaccine has been found to be relatively simple and cheap to apply, highly immunogenic, heat resistant and reduces reliance on refrigeration.

The objective of the study was to assess the serological responses of birds to vaccination with V and LaSota vaccines administered

| Table 1. Ab profile of chicks WK after vaccination with V via ED |
|-----------------|---|---|---|---|---|---|
| WK PV | 0 | 1 | 2 | 3 | 4 | 5 |
| Number in group | 20 | 19 | 18 | 9 | 9 | 9 |
| % with Ab titres of <2 log<sub>2</sub> (No.) | 100 | (26.3) | 5.6 | 0 | 0 | 0 |
| % with Ab titres of > 3 log<sub>2</sub> (No.) | 0 | 73.7 | 94.4 | 100 | 100 | 100 |
| Mean Ab titre log<sub>2</sub> | 0 | 3.1 | 4.6 | 6 | 8.8 | 8.0 |
| Range Ab titre log<sub>2</sub> | 0 | 0-6 | 0-8 | 0-9 | 0-11 | 0-10 |
| Variance | 0 | 1.5 | 2.1 | 1.6 | 2.4 | 1.9 |
through ED, DW or FD.

**Materials and Methods**

**Experimental design**

One hundred and forty Harco Black day-old chicks were randomly assigned to seven groups. Each group consisted of 20 birds. Group I, III and V were vaccinated with a Malaysian V<sub>4</sub> vaccine via ED, DW and FD respectively at the age of 5 WK. Those in group II, IV and VI were vaccinated with a Nigerian LaSota vaccine via the same routes and age. Birds in group VII were unvaccinated to serve as controls and were located in another pen outside other pens and managed by different attendants. The birds were bled prior to and 1 WK PV and their sera screened for NDV Ab.

Two WK PV, the birds in all vaccinated groups were divided into two halves after bleeding. Each half from each group was challenged while the remaining half was monitored weekly for NDV Ab response up to WK 5 PV when the experiment was terminated. The clinical signs and number of birds that died of challenge were recorded. The challenged birds were inoculated intranasally with 10-5 EID50 of a virulent ND virus strain, Herts 33/56, contained in 0.2 ml of phosphate buffered saline pH 7.2 (PBS). The virus was obtained from the National Veterinary Research Institute, Vom Nigeria (NVRI).

**Preparation of 1% Chicken Red Blood Cells (RBC)**

About 5 ml of chicken blood was collected into 10 ml of Alsevier’s solution and gently mixed. The RBC were washed 3 times with PBS by centrifugation at 3000 rpm for 5 min each. The concentration of RBC was adjusted to 1% by preparing a 5% suspension as described by Allan et al<sup>14</sup>.

**Newcastle disease virus antigen**

The antigen was prepared from live LaSota obtained from the NVRI. A 2.5 ml vial

| Table 2. Ab profile of chicks WK after vaccination with LaSota via ED |
|------------------|-----|-----|-----|-----|-----|-----|
| WK PV            |     |     |     |     |     |
|                  | 0   | 1   | 2   | 3   | 4   | 5   |
| Number in group  | 20  | 18  | 18  | 9   | 9   | 9   |
| % with Ab titres of = 2log<sub>2</sub> (No.) | 100 | 11.3 | 5.6 | 44.4 | 66.7 | 88.9 |
|                  | (20) | (20) | (1) | (4)  | (6)  | (8)  |
| % with Ab titres of = 3log<sub>2</sub> (No.) | 0   | 88.9 | 94.4 | 55.6 | 33.3 | 11.1 |
|                  | (0)  | (16) | (17) | (5)  | (3)  | (1)  |
| Mean Ab titre log<sub>2</sub> | 0   | 4.2  | 3.5  | 2.8  | 2.1  | 1.6  |
| Range Ab titre log<sub>2</sub> | 0   | 0-6  | 0-5  | 0-4  | 0-3  | 0-3  |
| Variance         | 0   | 1.5  | 0.8  | 1.2  | 0.6  | 0.5  |
was reconstituted in 8 ml of distilled water. The haemagglutination (HA) titre was determined as described by Beard\textsuperscript{15} and diluted to contain 4 HA units for use in the HA inhibition test (HIT).

**Haemagglutination Test**

The HA test was conducted by microtest method using two-fold serial dilutions of 50 ul of reconstituted antigen and 50 ul of the 1% chicken RBC was added to each well. Equivalent volume of RBC suspension was added to wells containing PBS alone to serve as control. The plate was gently tapped to mix the contents and after 45 min of incubation at room temperature, the end point of the HA was then read. The titre was taken as the reciprocal of the highest dilution giving a 100% agglutination of the 1% RBC. This amount of virus was also taken to represent 1HA unit.

**Haemagglutination Inhibition Test**

The HIT adopted was based on procedures described by Allan and Gough\textsuperscript{16}. Beta technique (constant virus and varying serum) against 4 HA units of antigen computed from the results of the HA titration was used. Double serial dilution (50 ul) of the different chicken sera were reacted with 50 ul of 4 HA units of the antigen suspension per well. The mixture was tapped gently to mix and allowed to stand for 30 min at room temperature. Antigen control wells were also included. A 50 ul of 1% washed RBC was added to all the wells and tapped to mix, incubated and read after 45 min. The titres were taken as the reciprocals of serum dilutions giving 100% inhibition of agglutination of the RBC.

**Statistical Analyses**

Geometric mean HI Ab titres were calculated for the Ab positive sera in each treatment group. One-way analysis of variance (ANOVA) and Duncan’s multiple range test (DMRT) were used to compare

| Table 3. Ab profile of chicks WK after vaccination with V \textsubscript{4} via DW |
|-----------------|---|---|---|---|---|---|
| Number in group | 20 | 18 | 17 | 9  | 9  | 9  |
| % with Ab titres of = 2 log\textsubscript{2} (No.) | 100 | 33.3 | 11.8 | 0.0 | 0.0 | 0.0 |
| % with Ab titres of = 3 log\textsubscript{2} (No.) | 0   | 66.7 | 88.2 | 100.0 | 100.0 | 100.0 |
| Mean Ab titre log\textsubscript{2} | 0   | 2.6  | 3.9  | 5.1  | 6.1  | 4.5 |
| Range Ab titre log\textsubscript{2} | 0   | 0.6  | 0.6  | 0.4  | 0.7  | 0.6 |
| Variance | 0   | 0.5  | 1.2  | 1.0  | 1.3  | 0.8 |
mean Ab titre following vaccination with V was higher (P>0.05) than the mean Ab titre following vaccination with LaSota using ED route as from 2 to 5 WK PV. The percentage of birds with Ab titre of $\geq 3 \log_2$ was also higher (P>0.05) at 3, 4 and 5 WK PV in V than LaSota vaccinated birds.

About 88.2% to 100% of the birds vaccinated with V vaccine via DW had Ab titre of $\geq 3 \log_2$ as from 2 to 5 WK PV. The mean Ab titre of vaccinated birds increased (P<0.05) 1 to 4 WK PV (Table 3). 84.2% of birds vaccinated with LaSota had Ab titre of $\geq 3 \log_2$ WK PV and then declined to 11.1% 5 WK PV. The mean Ab titre of birds vaccinated with LaSota via DW peaked to $3.4\pm1.5 \log_2$ 1 WK PV and declined to $1.6\pm0.1 \log_2$ 5 WK PV (Table 4). 70.6% of the birds vaccinated with V via FD achieved Ab titre of $>3 \log_2$ 2 WK PV and declined to 37.5% 5

**Results**

All birds vaccinated with V vaccine via ED as from 3, 4 and 5 WK PV achieved Ab titre of $\geq 3 \log_2$. The mean Ab titre 2 WK PV with V vaccine via ED was $4.6\pm2.1 \log_2$ and peaked to $8.8\pm0.3 \log_2$ 4 WK PV (Table 1). 94.4% of birds vaccinated with LaSota vaccine achieved Ab titre of $\geq 3 \log_2$ 2 WK PV. A peak mean Ab titre of $4.2\pm1.5 \log_2$ was recorded 1 WK PV (Table 2). The

| Table 4. Ab profile of chicks WK after vaccination with LaSota via DW |
|------------------|-----|-----|-----|-----|-----|
|                   | 0   | 1   | 2   | 3   | 4   | 5   |
| Number in group   | 20  | 20  | 19  | 9   | 9   | 9   |
| % with Ab titre of $= 2 \log_2$ (No.) | 100 | 20.0 | 15.8 | 22.2 | 44.4 | 88.9 |
|                   | (20) | (4) | (3) | (2) | (4) | (5) |
| % with Ab titre of $= 3 \log_2$ (No.) | 0   | 80.0 | 84.2 | 77.8 | 55.6 | 11.1 |
|                   | (0) | (16) | (16) | (7) | (5) | (1) |
| Mean Ab titre $\log_2$ | 0   | 3.4  | 3.2  | 3.3  | 2.7  | 1.6  |
| Range Ab titre $\log_2$ | 0   | 0.6  | 0.5  | 0.4  | 0.4  | 0.3  |
| Variance           | 0   | 1.5  | 0.8  | 8.0  | 0.7  | 0.1  |
Table 5. Ab profile of chicks WK after vaccination with V. via FD

<table>
<thead>
<tr>
<th>WK PV</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number in group</td>
<td>20</td>
<td>17</td>
<td>17</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>% with Ab titres of = 2 log&lt;sub&gt;2&lt;/sub&gt; (No.)</td>
<td>100</td>
<td>35.3</td>
<td>29.4</td>
<td>37.5</td>
<td>37.5</td>
<td>62.5</td>
</tr>
<tr>
<td></td>
<td>(20)</td>
<td>(46)</td>
<td>(5)</td>
<td>(3)</td>
<td>(3)</td>
<td>(3)</td>
</tr>
<tr>
<td>% with Ab titres of = 3 log&lt;sub&gt;2&lt;/sub&gt; (No.)</td>
<td>0</td>
<td>64.7</td>
<td>70.6</td>
<td>62.5</td>
<td>62.5</td>
<td>37.5</td>
</tr>
<tr>
<td></td>
<td>(0)</td>
<td>(11)</td>
<td>(12)</td>
<td>(5)</td>
<td>(3)</td>
<td>(3)</td>
</tr>
<tr>
<td>Mean Ab titre log&lt;sub&gt;2&lt;/sub&gt;</td>
<td>0</td>
<td>2.4</td>
<td>3.5</td>
<td>3.6</td>
<td>2.4</td>
<td>1.9</td>
</tr>
<tr>
<td>Range Ab titre log&lt;sub&gt;2&lt;/sub&gt;</td>
<td>0</td>
<td>0.4</td>
<td>0.6</td>
<td>0.6</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Variance</td>
<td>0</td>
<td>2.1</td>
<td>3.1</td>
<td>4.3</td>
<td>3.4</td>
<td>1.3</td>
</tr>
</tbody>
</table>

Table 6. Ab profile of chicks WK after vaccination with LaSota via FD

<table>
<thead>
<tr>
<th>WK PV</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number in group</td>
<td>20</td>
<td>18</td>
<td>18</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>% with Ab titres of = 2 log&lt;sub&gt;2&lt;/sub&gt; (No.)</td>
<td>100</td>
<td>5.8.8</td>
<td>83.3</td>
<td>88.9</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td></td>
<td>(20)</td>
<td>(11)</td>
<td>(15)</td>
<td>(8)</td>
<td>(9)</td>
<td>(9)</td>
</tr>
<tr>
<td>% with Ab titres of = 3 log&lt;sub&gt;2&lt;/sub&gt; (No.)</td>
<td>0</td>
<td>41.2</td>
<td>16.7</td>
<td>11.1</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>(0)</td>
<td>(7)</td>
<td>(3)</td>
<td>(1)</td>
<td>(0)</td>
<td>(0)</td>
</tr>
<tr>
<td>Mean Ab titre log&lt;sub&gt;2&lt;/sub&gt;</td>
<td>0</td>
<td>1.8</td>
<td>1.6</td>
<td>1.5</td>
<td>0.8</td>
<td>0.5</td>
</tr>
<tr>
<td>Range Ab titre log&lt;sub&gt;2&lt;/sub&gt;</td>
<td>0</td>
<td>0.4</td>
<td>0.3</td>
<td>0.3</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Variance</td>
<td>0</td>
<td>2.4</td>
<td>1.0</td>
<td>0.8</td>
<td>0.4</td>
<td>0.3</td>
</tr>
</tbody>
</table>
WK PV. The mean Ab titres of birds vaccinated with V via FD peaked to 3.6±4.3 log at 2 WK PV and declined to 1.9±1.3 log at 5 WK PV (Table 5). 41.2% of the birds vaccinated with LaSota in FD achieved Ab titres of >3 log 1 WK PV and declined to 0.0%, 4 and 5 WK PV (Table 6). 100.0% protection was offered to the birds by V and 77.8% of birds vaccinated with LaSota via ED survived the challenge. 100.0% of birds vaccinated with V in DW were protected. 70.0% protection was offered to birds vaccinated with LaSota through DW. 62.5% of the birds vaccinated with V in FD survived challenge. 11.1% birds survived the challenge when vaccinated with LaSota via FD. All birds in the control group that were challenged died (Table 7).

Within the first WK of vaccination, all the birds in the treatment groups with the exception of controls seroconverted. Also, in the first WK PV, birds vaccinated with LaSota achieved higher mean Ab titre of 4.2±1.3 log compared to 2.7±1.1 log in birds vaccinated

**Table 7. Mortality and percentage protection after challenge with Hert’s 33/56 2 WK PV**

<table>
<thead>
<tr>
<th>Group</th>
<th>Vaccine</th>
<th>Route</th>
<th>No. dead/total challenged</th>
<th>No. alive/total challenged</th>
<th>Protection (%)</th>
<th>Fisher’s exact test</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>V⁴</td>
<td>ED</td>
<td>0/9</td>
<td>0/9</td>
<td>100.0</td>
<td>P=0.42</td>
</tr>
<tr>
<td>II</td>
<td>Lasota</td>
<td>ED</td>
<td>2/9</td>
<td>7/9</td>
<td>77.8</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>V⁴</td>
<td>DW</td>
<td>0/8</td>
<td>8/8</td>
<td>100.0</td>
<td>P=0.21</td>
</tr>
<tr>
<td>IV</td>
<td>LaSota</td>
<td>DW</td>
<td>3/10</td>
<td>7/10</td>
<td>70.0</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>V⁴</td>
<td>FD</td>
<td>3/8</td>
<td>5/8</td>
<td>62.5</td>
<td>P=0.049</td>
</tr>
<tr>
<td>VI</td>
<td>LaSota</td>
<td>FD</td>
<td>8/9</td>
<td>1/9</td>
<td>11.1</td>
<td></td>
</tr>
<tr>
<td>VII</td>
<td>Control</td>
<td>Unvaccinated</td>
<td>10/10</td>
<td>0/10</td>
<td>0.0</td>
<td></td>
</tr>
</tbody>
</table>

**Table 8. Mean Ab titres of vaccinated birds based on type of vaccine used**

<table>
<thead>
<tr>
<th>WK PV</th>
<th>V HR</th>
<th>LaSota</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Mean Ab titre log₂)</td>
<td>(Mean Ab titre log₂)</td>
</tr>
<tr>
<td>1</td>
<td>2.7±1.1</td>
<td>4.2±1.3</td>
</tr>
<tr>
<td>2</td>
<td>4.1±1.5</td>
<td>2.8±0.9</td>
</tr>
<tr>
<td>3</td>
<td>5.0±1.5</td>
<td>2.5±1.0</td>
</tr>
<tr>
<td>4</td>
<td>5.8±3.1</td>
<td>1.9±0.8</td>
</tr>
<tr>
<td>5</td>
<td>4.8±3.0</td>
<td>1.3±0.6</td>
</tr>
</tbody>
</table>

Means in the same row with different superscripts are significantly different at P<0.05.
with V irrespective of the route of vaccination. This mean Ab titre in birds vaccinated with LaSota declined up to 1.3±0.6 log₂ at WK 5 PV. Birds vaccinated with V irrespective of route, exhibited increases in mean Ab titres from 1 (2.7±1.1 log₂) to 4 WK (5.8±3.1 log₂) PV (Table 8).

At WK 1 PV, birds vaccinated through ED gave the highest Ab titre when compared with other routes and it was different (P<0.05) from DW and FD routes, while DW route was different (P<0.05) from FD route. At WK 2 PV, even though the ED route gave the highest Ab titre, it was not different (P>0.05) from the Ab titre achieved through DW route, but both titres were different (P<0.05) from FD route. At WK 3, 4 and 5 PV, the ED route gave slightly higher Ab titre but it was not different (P<0.05) from DW route but both were different (P<0.05) from FD route (Table 9).

Within the 1 WK PV, birds vaccinated with LaSota via ED and DW showed no differences in mean Ab titres (P>0.05), but those vaccinated with LaSota via ED were different in mean Ab titres (P<0.05) from birds in groups I, III, V and VI. At WK 2 PV, group I had the highest mean Ab titres for birds vaccinated with V compared to others. The mean Ab titres in groups I and III were not different (P>0.05) but that of group I was different (P<0.05) from mean Ab titres of groups II, IV, V and VI. Also, the mean Ab titres of groups II, IV and V were not different (P>0.05) but were all different (P<0.05) from group VI. At WK 3 PV, the mean Ab titre of group I was the highest. However, the mean Ab titre of group I was not different (P>0.05) from those of group III but were both different (P<0.05) from groups II, IV, V and VI. The mean Ab titres of groups II, IV and V were not different (P<0.05) but were different (P<0.05) from

<table>
<thead>
<tr>
<th>Route of vaccination (Mean Ab titre in log₂)</th>
<th>ED</th>
<th>DW</th>
<th>FD</th>
</tr>
</thead>
<tbody>
<tr>
<td>WK PV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>3.6±1.4</td>
<td>3.0±1.4</td>
<td>2.2±1.4</td>
</tr>
<tr>
<td>2</td>
<td>4.1±1.5</td>
<td>3.6±1.5</td>
<td>2.6±1.5</td>
</tr>
<tr>
<td>3</td>
<td>4.5±1.0</td>
<td>4.2±1.0</td>
<td>2.6±1.0</td>
</tr>
<tr>
<td>4</td>
<td>5.5±3.9</td>
<td>4.4±3.9</td>
<td>1.6±3.9</td>
</tr>
<tr>
<td>5</td>
<td>4.8±3.6</td>
<td>3.1±3.6</td>
<td>1.2±3.6</td>
</tr>
</tbody>
</table>

Means in the same row with different superscripts are significantly different at P<0.05
those group of IV. The mean Ab titres of groups II and IV were not different (P>0.05). At WK 4 PV the mean Ab titre of group I was still higher when compared to that of other groups. The mean Ab titres of groups I and III were not different (P>0.05) but were both different (P<0.05) from those of groups II, IV, V and VI. The mean Ab titres of groups II, IV, and VI

<table>
<thead>
<tr>
<th>Table 10. Summary of mean Ab titres of vaccinated birds in treatment groups</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Treatment group vaccine and route of vaccination</strong></td>
</tr>
<tr>
<td>WKPV</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
</tbody>
</table>

Means in the same row with different superscripts are significantly different at P<0.05

<table>
<thead>
<tr>
<th>Table 11. Mean Ab titres of birds vaccinated with V(_4) and LaSota via different routes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vaccine</strong></td>
</tr>
<tr>
<td>WKPV</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Mortality rate in birds vaccinated with LaSota and challenged was 6.4 times higher than in birds vaccinated with V\(_4\) (Table 12). This difference in mortality rate was significant (95% CI on OR: 1.34<OR<34.23). There was a difference (P<0.05) in the level of protection for the different routes of vaccination (Table 12).
were not different (P > 0.05) from each other. At WK 5 PV, group I had the highest Ab response compared to others and it was different (P < 0.05) from another groups. The mean Ab titre of groups II, III, IV and V were not different (P > 0.05) from each other but that of group III was different (P < 0.05) from the mean titre of group VI (Table 10).

Within the first one WK of vaccination Lasota achieved higher mean Ab titre of 4.2 ± 1.2 log2 and 3.4 ± 1.2 log2 via ED and DW routes respectively than the mean Ab titre of 3.1 ± 1.2 log2 and 2.5 ± 0.7 log2 achieved by V4 via ED and DW routes respectively. However, V4 in FD achieved a higher mean Ab titre of 2.4 ± 1.4 log2 than mean Ab titre of 1.9 ± 1.4 log2 achieved by Lasota in FD within the same period. From WK 2 to 5 PV, V4 vaccinated birds had higher mean Ab titre in all routes compared to Lasota vaccinated birds (Table 11).

Discussion

The sera collected at the time of vaccination of chicks were negative for Ab to NDV, suggesting that they had not been exposed to NDV, were either hatched from unvaccinated breeders or that maternally derived antibodies (MA) to NDV acquired from their parents have waned at 5 WK of age. MA in newly hatched chicks may only last for 5 WK and those chicks were also fully capable of mounting immune response at about the same age. 1 WK PV, there was evidence of seroconversion in all vaccinated groups. This observation is similar to past reports, which noted that Ab response to NDV starts 6–8 days after natural infection or vaccination. Ambali et al. and Usman also made similar observations in vaccination trials in keets and chicks respectively with V4 and Lasota administered via DW. Bell et al. in their trials with V4 in broilers and layers via aerosol and DW also reported that there was no evidence of seroconversion in vaccinated birds before 7 days PV.

The low Ab response to Lasota observed in this study is similar past reports. However, the Ab response in this study was slightly lower than that reported by Usman in DW and FD at WK 4 and 5 PV respectively, but much lower than that reported by Shamaki et al. This low Ab level obtained with Lasota could be attributed to the rate of water intake by individual birds during vaccination, time lag between vaccine reconstitution and administration and the potency and strain of the vaccine used. The possible explanation for the low Ab response to Lasota in this study
Experimental trials with VHR and LaSota Newcastle disease virus vaccines administered to chicks via eye drop, drinking water and commercial feed.

may also be due to vaccine handling from the source of manufacture as the birds vaccinated with LaSota and V4 were subjected to similar experimental conditions. The high and persistent mean Ab titre observed in birds vaccinated with V4 vaccine confirms past in which vaccination of birds with V4 resulted in a significant increase in the mean Ab titre which was detected 1 WK PV19,21,22,24. The sustained high mean Ab titres observed in V4 vaccinated birds was reported to be rarely found with other lentogenic strains of NDV used as vaccines19.

With V4 and LaSota it was observed in the present study that birds vaccinated via ED produced higher mean Ab titres and protection on challenge compared to DW and FD routes. Reports by Alders and Spradberry9 also showed that when V4 was administered in DW, it was easier but provoked a lower level of immunity than ED and may require frequent application. Okeke and Lamorde4 and Usman20 obtained the same result with LaSota. The mean Ab titre achieved in birds vaccinated with both vaccines in FD was the lowest compared to other routes; very low level of protection was recorded in birds vaccinated via FD irrespective of vaccine type. This result confirms earlier reports by Aini et al.24, Alders and Spradberry9 and Usman20. However, birds vaccinated with V4 in FD produced a higher Ab titre and high level of protection on challenge compared to those vaccinated with LaSota. The high performance of the V4 irrespective of the route compared to LaSota confirms the reports of Anon25. Alders and Spradberry9, Spradberry9 reported that V4 is efficacious when administered in birds via ED, nose-drop, oral drench or DW, mixed with certain feeds or by injection but, Usman20 recorded a higher immune response with LaSota than V4 in DW contrary to the results of this study. The reason for this difference could be attributed to the handling of the vaccine at the source or fault at point of manufacture or the health status of the birds used.

Vaccinated birds with Ab titres of >3 log2 were protected against challenge. However, the study showed that birds with mean Ab titre of >4 log2 were fully protected and none died when challenged. The correlation between the achieved mean Ab titres due to vaccination and level of protection against challenge closely agreed with the study of Westbury et al.26 who reported the Ab titres of >3 log2 to be protective in young chickens. Bell et al.21 reported that all V4 vaccinated birds with Ab titres of >4 log2 survived challenge and this is in agreement with OIE27 recommendation. Allan and Gough16 also reported a titre of 3 log2 as indicative of immunity in vaccinated birds. Although the HIT has been reported to be unable to detect low levels of circulating Ab it is however an accepted indicator of the immune status of a flock when individual serum are tested after vaccination28. Also, the protection of birds against challenge was better in birds vaccinated with V4 using all routes than with LaSota. ED vaccination was better compared to other routes. However, protection against challenge was poorest in birds vaccinated via FD compared to other routes but, better in birds vaccinated with V in FD compared to birds vaccinated with LaSota in FD. It could be concluded that V was more immunogenic than LaSota and the ED was the best route of administration for both vaccines.

Acknowledgements

We are grateful to Prof (Dr.) Aini Ideris of the Faculty of Veterinary and Animal Science, University Pertanian, Malaysia, Prof. Dr. Abd Latif Ibrahim of the National Biotechnology Directorate, Ministry of
Science, Technology and Environment, Malaysia, Dr. Roshidah Ismail and Dr. Mazlan Mohammad of Malaysian Vaccines and Pharmaceuticals SBN, BHD, Malaysia for their efforts in making the V4 vaccine available to us at no cost.

References


Received for publication on 14th November, 2005
SHORT COMMUNICATION

AN OUTBREAK OF ACUTE BOVINE DERMATOPHILOSIS IN A LARGE SCALE DAIRY HERD IN KENYA

J.K. WABACHA*, N.P. GITONGA, M.J. NJENGA, A.G. THAIYAH
and C.M. MULEI

Department of Clinical Studies, Faculty of Veterinary Medicine, University of Nairobi,
P.O. Box 29053, Nairobi, Kenya

Dermatophilos, caused by Dermatophilus congolensis, is a disease that affects mainly cattle, sheep, camels, horses and goats and occurs as an acute or chronic exudative skin disease1. Injury of the skin by insect and tick bites and thorny bushes accompanied by prolonged wetting are thought to be important predisposing factors1,2. Affected animals initially develop moist, round, circumscribed papules that later turn to scabs and crusts whose location is highly variable3,4.

In tropical and subtropical areas, the disease can be epizootic and can result in considerable economic losses as a result of lost production, premature culling, treatment costs and downgrading of hides and skins1,5. Although the clinical disease has been recognised in several African countries1,6,7,8 the occurrence of clinical disease in Kenya was only recently reported in three dairy cows in a zero grazing unit9. This case report describes an outbreak of acute bovine dermatophilos in a large scale dairy herd and highlights that the disease in Kenya could occur in outbreak proportions and in clinically severe form as has been reported in other countries in West and Central Africa. We believe that this is the 1st documented outbreak of a severe form of bovine cutaneous dermatophilos in exotic dairy animals in Kenya.

On 26th November 2005, the manager of a large scale dairy farm with 262 heads of cattle reported the occurrence of skin lesions in two yearling heifers.

At the farm, a clinical history of the condition was taken and this was followed by a clinical examination of the two yearling heifers. The examination revealed that yearling and bulling heifers were pastured during the day and paddocked at night. The rest of the animals were confined and fed in well-fenced paddocks. The main clinical signs in the two heifers were grey-white, crusty, localised lesions on the lateral neck. By 30th November 2005, 44 out of the 74 yearling and bulling heifers were noted to have similar lesions. In the month of December 2005, sixty-eight (68) new cases broke out and this time it involved weaned calves as well as the yearling and bulling heifers. A total of 114 (43.5%) cases were observed during the outbreak period that lasted from mid November 2005 to early January 2006 when the weather was rainy. The mean monthly rainfall were 33mm, 105 and 24mm for October, November and December 2005 and 13mm for Jan 2006.

Two types of skin lesions were observed in the affected animals. The most common lesions were manifested as discrete, circumscribed lesions of variable sizes that were covered with grey-white crusts (Figure 1).
Some crusts had coalesced to form large lesions covering large areas of the skin (Figure 2). The pustular lesions were less common and involved the formation of small scabs protruding above the skin surface causing the hair over the affected site to be erect and matted in tufts (paintbrush lesion) (Figure 3). Removal of the crusts from the discrete circumscribed lesions revealed an alopecic, red, moist epidermis oozing either blood or serum. The lesions of the pustular form were evenly distributed over the whole skin surface while for the crusty form, the lesions were mainly on the lateral neck, head region, brisket and down the hind limbs.

A tentative diagnosis of cutaneous bovine dermatophilosis was made on 26th November 2005 and the affected heifers were isolated from the rest of the animals. Some skin scrapings were taken from the lesions for bacterial isolation and characterisation. The scrapings were directly streaked on blood agar and incubated at 37°C. The growth was relatively slow, forming grey raised granular colonies in 72 hours which were adherent to the medium and produced a β-haemolysis. Gram stain of the colonies revealed Gram-positive cocci in rows of multiseptate branched filaments which is characteristic of *D. congolensis*.

All the affected animals were treated on 30th November 2005 with a single intramuscular injection of 20mg/kg long-acting oxytetracycline (Centrivet®, Norbrook laboratories). The animals with severe lesions received a second injection after 5 days on 5th December, 2005. New cases in December, 2005 and January, 2006 received the same regime of

*Figure 1. Circumscribed greyish crusty lesions on the neck of a bulging heifer oozing blood and serum (arrows)*
Figure 2: Confluence of the lesions and areas where crusts had fallen off leaving alopecic areas oozing blood and serum (arrows)

Figure 3: A bulling Heifer with small horny scabs protruding above the skin surface
treatment. Lesions began to dry off 3 days following treatment and regression of lesions was complete after 4 weeks.

The disease was observed first in heifers that were being grazed on pastures. The hard prickly pastures that the animals were grazing on following prolonged draught accompanied with wetting from the rains could have contributed to the occurrence of the disease on the face, the neck and the extremities, for the initial cases, as has been reported previously\(^1,2,3\). The high population of flies at the time could have contributed to the occurrence of pustular lesions all over the body\(^4\). The clinical signs observed in the present outbreak were similar to those reported for dermatophilosis in cattle\(^1,2,3,4,5\). The weaner calves, though they were in isolation from the infected heifers, came down with the clinical disease and this was attributed to insect bites.

The isolation and morphological identification of \textit{D. congolensis} supported the clinical diagnosis. In the present outbreak, the crusts were grey-white, greasy and firmly attached to hair fibres and when removed they left a red, moist epidermis oozing serum or blood. These findings were consistent with dermatophilosis lesions as described in the literature\(^1,2,3,4,5\). The treatment of the animals with long-acting tetracycline at 20mg/kg body weight intramuscularly was able to cure the animals and this was in agreement with previous findings\(^5\). Other drugs that have been shown to be effective include, procaine penicillin combined with streptomycin, erythromycin and a combination of lincomycin and spectinomycin\(^5\).

Considering the large number of animals involved, and the severity of the lesions, that necessitated veterinary intervention, it would be necessary to assess the prevalence and economic importance of the disease in dairy herd establishments in Kenya.

Acknowledgements

We acknowledge the cooperation and commitment of the farm Manager and his stockmen during the investigation.

References


Received for publication on 24th March, 2006
SHORT COMMUNICATION

INCIDENCE OF PESTE DES PETITS RUMINANTS HAEMAGGLUTININS IN FARM AND MARKET GOATS IN NSUKKA, ENUGU STATE, NIGERIA

R.I. OBIDIKE1*, M.C.O. EZEIBE2, J.T.N. OMEJE3 and K.G. UGWUOMARIMA3

1Department of Veterinary Physiology and Pharmacology, University of Nigeria, Nsukka
2Department of Veterinary Medicine, University of Nigeria, Nsukka
3Faculty of Veterinary Medicine, University of Nigeria, Nsukka

Small ruminants, sheep and goats, are important sources of animal protein in the West African sub region. This is so because trypanosomosis, which makes raising of cattle in the region difficult1, has less effect on small ruminants. Leather industries also benefit much from these ruminants2.

Peste des Petits Ruminants (PPR) has been described as the most destructive viral disease of sheep and goats in the humid West African sub-region3. It was observed that PPR is a source of great economic loss to farmers and stock owners in Nigeria4. In the period, 1978-1979, a total of 2,700 goats were affected in 191 outbreaks resulting in the death of 1115 animals in Oyo State, Nigeria5. PPR affects the quality and quantity of goat milk.

Diagnosis of PPR in sheep and goats can be by virus isolation6. Also, serological tests have been described for confirmation of PPR7,8,9. Haemagglutination test for confirmation of PPR has been described10. There are standardized conditions for haemagglutination test for the diagnosis of PPR11. Today haemagglutination test and the corresponding haemagglutination-inhibition test are used to diagnose PPR in sheep and goats. Evidence of goats which recover from PPR and continue to secrete the virus up to 12 weeks post recovery abound11.

The present study was therefore designed to screen apparently healthy goats in farms and local markets in Nsukka zone to investigate the incidence of the disease in these animals.

Three local government areas were chosen by random selection within the nine local governments which constitute Nsukka senatorial zone. One hundred and twenty farms were similarly chosen from the three local government areas. Then one goat was randomly sampled.

From each of the goats selected from the farms or the markets, faecal samples were collected with gloved hands per rectum. The faecal samples were put in sterile bottles and stored at 20°C until needed.

To process the faecal samples, 2ml of phosphate buffered saline (PBS) was added to each gram of faeces in test tubes. The faeces were then mashed in the test tubes and stored at 20°C for 24 hours before they were centrifuged at 3000 revolutions per minute for 10 minutes. The supernatants were used as antigens in haemagglutination test6,10. As diluent, PBS (pH 6.8) was used6,10. The RBC used was 0.6% chicken RBC12.

For the virus control, PPR specific
antiserum was added to the PBS-antigen mixture before the chicken RBC were added. Production of haemagglutination by any of the faecal extracts while the PPR specific anti-serum inhibited the agglutination in the viral control wells was interpreted to mean that PPR haemagglutinins were present in the faeces of the affected goats. Reciprocal of the highest dilution of the faecal extracts which gave a complete haemagglutination (100%) was recorded as the HA titre of the faecal extract.

Of the one hundred and twenty farm goats sampled, ninety-four were positive for PPR virus haemagglutinins (78.3%). None of the farms had PPR outbreak 2 weeks after the samples were collected. Haemagglutination titres of the farm and market goats sampled are shown in Tables 1 and 2. Similarly, out of the one hundred and twenty apparent healthy goats sampled for PPR virus from four markets in the zone, seventy were positive for PPR virus haemagglutinins (58.3%).

The 78.3% and 58.3% incidence of PPR among healthy goats in the farms and markets respectively in this study shows high levels of infection among animals regarded as healthy since there was no outbreak of the disease among the screened goats two weeks after the screening. It also suggests that these animals may be healthy carriers of PPR virus. These animals may serve as nidus of infection to healthy sheep and goats in the farms and markets. This may explain the common phenomenon that when goats are bought from the market and introduced into farms, it often leads to an outbreak of PPR in

<table>
<thead>
<tr>
<th>Table 1: HA (PPR) titres of the faecal samples of healthy goats in farms in Nsukka zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Samples</td>
</tr>
<tr>
<td>26</td>
</tr>
<tr>
<td>15</td>
</tr>
<tr>
<td>25</td>
</tr>
<tr>
<td>36</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2: HA titres of faecal samples of market goats in Nsukka zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Samples</td>
</tr>
<tr>
<td>25</td>
</tr>
<tr>
<td>17</td>
</tr>
<tr>
<td>12</td>
</tr>
<tr>
<td>11</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
</tbody>
</table>
the farms\textsuperscript{13}. Similarly, a healthy carrier from the farm that is taken to the market for sale may shade the virus within the vicinity of the normal healthy market goats. Some of these outbreaks of PPR involve the older inmates of the farm or market, while new goats remain healthy\textsuperscript{11}.

At times, the healthy carriers may come down with the disease due to stress factors\textsuperscript{14, 15, 16, 17}. This may also explain the seasonal incidence of PPR disease\textsuperscript{18, 17}.

In Nigeria, it has been reported that the highest incidence of PPR occurs during the harmattan season\textsuperscript{17}. The harmattan period is also a period when most farmers allow their animals (sheep and goats) to graze in the farms after crop harvest. This free grazing gives animals from different farms and locations the opportunity to meet and graze as a flock. Under this condition, healthy carriers may shade the virus and contaminate the environment.

Other factors, which tend to favour outbreak of PPR include malnutrition, stress of transportation or overcrowding\textsuperscript{14, 15, 9}. All these environmental factors appear to lead to break down of the animals' immunity thereby exposing the animal to the disease.

The result of this study has shown that quarantine measures alone may not prevent introduction of PPR virus into a healthy flock. Screening of new animals before they are introduced to a farm or before they are taken to the market for sale, by the use of their faecal samples for haemagglutination test may help to prevent introduction of PPR virus into healthy flocks.

References


Received for publication on 02nd September, 2005
References


SHORT COMMUNICATION

FORMULATING MULTINUTRIENT FEED BLOCKS TOWARDS IMPROVING PRODUCTION AND REPRODUCTION OF DJALLONKÉ SHEEP

B. BOUKILA¹, T. E. PAMO²*, F. A. FONTEH², F. DOUMBIA¹, F. TENDONKENG², J. R. KANA², A.V. MBOKO¹ AND L.N. MBENGA¹.

¹Animal Nutrition Laboratory, Department of Animal Production, FASA, University of Dschang. P.O.Box.: 222 Dschang, Cameroon.

²Institut National Supérieur d’Agronomie et de Biotechnologie (INSAB), Université des Sciences et Techniques de Masuku, B.P. 941. Gabon.

In Cameroon, the sheep is an integral part of domestic livestock. However, its productivity in terms of growth and reproduction is very low because of poor nutritive quality of the available grasses especially during dry season²,³,⁴,⁵, and (b) deficiency of some essential minerals are known to retard body growth and reproduction⁶. To optimise the production potential of the sheep, appropriate nitrogen and mineral supplementation is, therefore, necessary. Although several types of good quality nitrogen sources, such as concentrates, fish and meat meals etc. are available⁴,⁷,⁸, these are very expensive and beyond the reach of the average Cameroonian farmer. Feed blocks based on agro-industrial wastes have been reported as cost-effective and excellent sources of nitrogen for supplementing feed in cattle and other domestic ruminants in several tropical countries⁴,⁹,⁷,⁸. The objective of the present study was to develop a suitable Multinutrient feed block (MNB) using cheap agricultural by-products available in Cameroon and to evaluate the effects of their supplementation on the productive performance of Djallonké sheep.

The blocks were prepared using the formula proposed by Moujahed et al.⁹ with slight modification. The composition was: Molasses (30%), Wheat bran (25%), Palm kernel (12%), Urea (10%), Cement (8%), Common Salt (7%), Bone meal (5%), White lime (2%) and Shell (1%).

All the dry ingredients were first mixed together and molasses was later added slowly while stirring the mixture. A small amount of water was added to obtain a semi solid paste. Once fully mixed, the paste was put into a wooden frame measuring 4x2x2 units. The material was force pressed into the slots by hands. Before putting the mixture into the wooden frame, a polythene sheet was spread all over the frame, ensuring complete lining of the slots with it. The blocks formed were then removed from the frame and allowed to air dry for about a week. They were then enveloped with a polythene sheet to avoid contamination / humidification during storage.

A simple and cheap mineral block was prepared as per Daget¹⁰ using locally available ingredients. The composition was: Clay

*Corresponding author: E-mail: pamo_te@yahoo.fr / pamo-te@excite.com
(7.5%), Cement (7.5%), Common Salt (23.6%) and Bone meal (61.4%). All the dry ingredients were first ground and mixed uniformly. A small quantity of water was added gradually to make it semi-solid. The mixture was put in the polyethylene lined wooden frame with slots of 4x2x2 and the blocks prepared the same way as UMMB. Both the UMMB and the MB were subjected to laboratory analysis for various nutrients according to Goering and Van Soest\textsuperscript{11} and AOAC\textsuperscript{12}.

The study was carried out from July – October on 21 sheep divided into three groups of seven each. The animals were grouped uniformly according to body weight and the body condition score. The sheep were grazed on a mixed pasture of \textit{Brachiaria ruziziensis} and \textit{Pennisetum purpureum} during the day and housed at night in pens containing supplements. One block of UMMB (10 kg) was provided to the sheep in the first group while MB was provided to sheep in the second group. The third group was unsupplemented.

The blocks were weighed at the end of each week and difference in weight was indicative of the quantity consumed per week.

Changes in body weight were recorded fortnightly from onset of the trial for three months. The total weight gained by the animals was calculated from the difference in their body weight at the start and the end of the study. Body condition score (BCS) of sheep in each group was taken at the end of the study. Data on body weight and body condition score was subjected to statistical analysis and comparison between groups was done\textsuperscript{13}.

There was no evidence of fungus growth on the blocks during a period of 12 months of storage. The chemical composition of the blocks is given in Table 1.

All the animals readily accepted the blocks offered to them. On average, the sheep consumed between 184 to 375 g of UMMB and 82 to 105 g of MB per animal, per day. The consumption of each block was on the
higher side in the beginning, which subsequently fluctuated inconsistently.

Changes in body weight of sheep in all the groups during the entire period of study are given in Figure 1. The sheep receiving UMMB supplement gained more weight than others but the differences were non-significant. The average daily weight gain during the study, however, was significantly higher (P<0.001) in the sheep receiving UMMB supplement as compared to the sheep receiving MB and control respectively (41.9±6.17 vs 25.23±7.86 vs 20.23±8.40 g/head/day). The BCS at the end of the study was significantly higher (p<0.05) in the UMMB (2.60±0.36) and the MB (2.39±0.43) supplemented groups than the control (1.77±0.50).

The blocks prepared in this study were of acceptable texture and taste as, sheep readily consumed them. Similar result was also reported earlier4,7,8,14. While the UMMB was rich in organic matter and crude protein ensuring nitrogen and energy to the animals, the MB contained only minerals. The sheep on UMMB supplementation gained significantly more weight (P<0.05) than those in the control group. The same result was reported earlier14,15,16. This could be the effect of additional nitrogen and minerals provided by the UMMB17,16,14. This can be explained by the fact that microbial growth efficiency in the rumen must have been enhanced by the presence of both urea and minerals whose deficiencies are widespread in the tropics.

The sheep receiving MB did not gain appreciably more body weight than controls. The trial was carried out during the rainy season, when pasture in grazing land is of reasonably good quality and could have been providing on average the required levels of minerals. Although the MB was a good source of minerals, it appears therefore that not the minerals alone, nitrogen and energy supplementation, as in UMMB, might be more beneficial in meeting the protein and energy requirements of the animals and in fully exploiting their genetic potential. Similar observations on the usefulness of the UMMB have also been reported in the past7,9,14,16,18.

The production cost of UMMB was 107.5 frs CFA/ Kg. Each sheep consumed about 27 kg of UMMB over a trial period of 3 months costing 2 900 frs CFA. In turn, it gained about 1.8 kg more body weight, the market price of which is 4000 frs CFA. Accordingly, each sheep yielded additional benefit of 4000 frs CFA in lieu of 2900 frs CFA additional inputs. This resulted to a benefit of 1100 frs CFA, with a cost-benefit ratio of 1:1.4 in terms of weight gain alone.
Acknowledgement

The authors are grateful to the International Atomic Energy Agency (IAEA), the University of Dschang and the Ministry of Higher Education of Cameroon for their financial support to the present work.

References


Received for publication on 28th April, 2005
BULLETIN OF ANIMAL HEALTH AND PRODUCTION IN AFRICA

Editor
Dr. Modibo T. Traoré D.V.M., M.Sc., DESS. Ph.D.

Assistant Editor
Dr. George K. Gitau, B.V.M., M.Sc., Ph.D.

Members of Editorial Board
Prof. A.L. Abate, B.Sc., Ph.D.

Dr. Reuben O. Mosi, B.Sc., M.Sc., Ph.D.

Dr. Solomon J.M. Munyua, B.V.M., B.Sc., MPhl., P.h.D.

Dr. Bidjeh Kebkiba, D.V.M. M.Sc., Ph.D.

Dr. Emmanuel Tambi, B.A. M.Sc., Ph.D.

Prof. Getachew Tilahun, B.V.M., M.Sc.

Prof. Ndichu Maingi, B.V.M., M.Sc., Ph.D.

Prof. Lamido T. Zaria, D.V.M, MSc., Ph.D.

Dr. Gavin Thomson, B.V.M., MSc., Ph.D.

Dr. Duncan Mwangi, B.V.M., M.Sc., Ph.D.

Dr. Roger Pelle, M.Sc., Ph.D.

Dr. Oumar Dialll, B.V.M., Ph.D.

Dr. Aimé J. Nianogo, BSc., M.Sc., Ph.D.

Dr. Okeyo Mwai, B.Sc., MSc., Ph.D.

Dr. Mamadou D. Coulibaly, M.Sc., Ph.D.

Dr. Tamboura H. Hamadou, D.V.M, M.Sc., Ph.D.

Prof. A. A. Aganga, B.Sc., M.Sc., Ph.D.
AFRICAN UNION
INTERAFRICAN BUREAU FOR ANIMAL RESOURCES

STAFF LIST

Director
Dr. M.T. Traoré D.V.M., M.Sc., DESS. Ph.D.

Ag. Documents Officer
C.K. Waiyaki, B.B.A.

PACE Liaison Officer
Dr. R. Bessin, Docteur Vétérinaire, Dip. Microbiol.

Translator
M. Ranaivoson
RECOMMANDATIONS AUX AUTEURS

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

Présentation des articles
Deux exemplaires des articles doivent être adressés à Monsieur le Rédacteur en Chef, Bulletin de la Santé et de la Production Animales en Afrique, Union Africaine/Bureau interafricain des Ressources animales, P.O. Box 30786, 00100 Nairobi, Kenya. E-mail: iobar.office@au-iobar.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.
- le courrier des lecteurs.
- analyse d'ouvrages.
- informations et annonces.

Format des articles
Les manuscrits doivent respecter les conditions suivantes : Le titre doit être concis et ne pas dépasser plus de 15 mots, il est suivi du (des) nom(s) de l'auteur (ou des auteurs) et des établissements où le travail a été effectué, ainsi que de l'adresse pour les correspondances si elle n'est pas la même.

Le résumé ne doit pas dépasser 200 mots. Son texte bref et concis comprendra les principaux résultats et la (les) conclusion(s) de l'étude.

L'introduction expose le but de la recherche.

Le matériel et les méthodes utilisés.

Les résultats présentés brièvement.

Un débat sur l'importance de l'article.

Remerciements éventuels.

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

La bibliographie doit respecter la présentation suivante :

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

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

3. Rapport annuel
Le nom du pays, l'année faisant l'objet du rapport, puis le nom du service ou de l'organisation, le numéro de la première page.

Si le même auteur est cité plus d'une fois, ses publications seront indiquées dans l'ordre chronologique dans la liste bibliographique et s'il y a plus d'une publication, les lettres "a, b, c," seront ajoutées aussi bien dans la liste bibliographique que dans le texte.

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

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

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

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

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

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