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

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# ORIGINAL ARTICLES

1. The prevalence of bovine mastitis, bacterial isolation and their susceptibility to antibiotics in central Ethiopia. T. SEYOUM, G. AMENI and M. ASHENAFI .................................................. 182

2. Age at first calving, calving interval and milk yield performance of Friesian-Boran crossbred cattle at Cheffa state farm, Wollo, Ethiopia. G. GOSHU and B. P. HEGDE .......................................................... 190

3. Assessment of the efficiency of dairy cow evaluation methods. R. O. MOSI and M. MUNUVE .......................................................... 198

4. Seasonal and species variations in erythrocytes osmotic fragility of indigenous poultry species in Zaria, Northern Guinea savannah zone of Nigeria. S. B. OLADILE, J. O. AYO, S. O. OUNDIFIPE and K. A. N. ESIEVO .......................................................... 204


# SHORT COMMUNICATIONS

6. Response of *Dictyocaulus filaria* third stage larvae to various stimuli. M. NEGASH .......................................................... 223


THE PREVALENCE OF BOVINE MASTITIS, BACTERIAL ISOLATION AND THEIR SUSCEPTIBILITY TO ANTIBIOTICS IN CENTRAL ETHIOPIA

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PREVALENCE DE LA MAMMITE BOVINE, ISOLEMENT DE LA BACTERIE ET SENSIBILITE AUX ANTIBIOTIQUES DANS LE CENTRE DE L'ETHIOPIE

Résumé

Une étude transversale a été conduite sur 243 vaches en lactation dans la ville de Muke-Turri au centre de l'Ethiopie de novembre 2002 à mai 2003, pour déterminer la prévalence de la mammite, isoler la bactérie provoquant la mammite et déterminer les types de chimiosensibilité des isolats. L'examen clinique et visuel de la mamelle et du lait respectivement, le test CMT (California Mastitis Test), la culture bactériologique, les tests biochimiques et les tests de chimiosensibilité ont été utilisés. La prévalence de la mammite clinique et infraclinique chez le troupeau était de 24,14% (35/145) et 42,07% (61/145) respectivement. La prévalence de la mammite clinique et infraclinique chez un animal individuel était de 15,23% (37/243) et 33,74% (82/243) respectivement. Le rapport mammite clinique/mammite infraclinique pour un animal était de 1 : 2,22. Les isolats bactériens dominants chez les animaux qui ont fait l'objet d'études étaient : les espèces Staphylococcus (33,33%), les espèces Microoccus (26,67%), les espèces Bacillus (15%), les espèces Streptococcus (8,33%) et les membres d'Enterobacteriaceae (6,67%). Tous les isolats de staphylococcus étaient sensibles à l'ampicilline et à l'érythromycine, mais seuls 90% d'entre eux étaient sensibles à la tétracycline. Tous les isolats de Streptococcus étaient sensibles à la gentamycine, au nitrofurantoin et à la streptomycine. Tous les isolats de l'Enterobacteriaceae étaient sensibles à l'érythromycine, à la gentamycine, au nitrofurantoin et à la streptomycine. Par ailleurs, tous les isolats qui constituaient la flore dominante étaient résistants à la penicilline G. Il faudrait, pour le contrôle de la mammite, une combinaison de traitement avec des antibiotiques efficaces et une bonne gestion de l'élevage de bétail laitier.

Mots - clés: laiterie, mammite, prévalence, chimiorésistance.

Summary

A cross-sectional study was conducted at Muke-Turri Town, Central Ethiopia from November 2002 to May 2003 on 243 lactating cows to determine the prevalence of mastitis, isolate the dominantly mastitis causing bacteria, and determine the drug susceptibility patterns of the isolates. Clinical and visual examination of the udder and milk, respectively, California Mastitis Test (CMT), bacteriological culturing, biochemical tests, and drug susceptibility tests were used. The herd prevalence of clinical and subclinical mastitis was 24.14% (35/145), and 42.07% (61/145), respectively. The individual animal prevalence of clinical and subclinical mastitis was 15.23% (37/243), and 33.74% (82/243), respectively. The ratio of clinical mastitis to subclinical mastitis at animal level was 1.22. The dominant bacterial isolates in the study animals were Staphylococcus species (33.33%), Microoccus species (26.67%), Bacillus species (15%), Streptococcus species (8.33%), and members of Enterobacteriaceae (6.67%). All Staphylococcus isolates were susceptible to Ampicillin and Erythromycin whereas only 90% of them were susceptible to Tetracycline. All Streptococcus isolates were sensitive to Gentamycin, Nitrofurantoin and Streptomycin. All the isolates of the Enterobacteriaceae were susceptible to Erythromycin, Gentamycin, Nitrofurantoin, and Streptomycin. On the other hand, all isolates that constituted the dominant flora were resistant to Penicillin G. Combination of treatment with effective antibiotics and practicing good dairy management are required for the control of mastitis.

Key words: Dairy, mastitis, prevalence, drug resistance.

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Introduction

Presently, the Ethiopian population is 67 million, and is growing at an annual rate of 3%. On the other hand, the country possesses 33.8 million cattle. These figures reveal the increase in the demand of milk for feeding the projecting human population. Nevertheless, the quantity of the presently produced total national milk, which is estimated to be 780,000 to 830,000 tons, is by far below the requirement of the population. Moreover, its quality deteriorates because of various causes. The incriminated biological causes include the low genetic potential of the animals, poor nutrition and prevalence of diseases. Mastitis is one of the diseases that cause reduction of in milk production and deterioration of its quality. Results of previous studies on the prevalence of sub-clinical mastitis in and around Addis Ababa indicated prevalence of 34.3% and 30.2% on the basis of CMT and microbiological examinations, respectively. The prevalence of sub clinical mastitis was higher in farms with larger herd size than in those with lower herd sizes. As compared to sub clinical mastitis, relatively lower prevalence (5.5%) of clinical mastitis has been reported. The results of a similar study in Southern part of Ethiopia indicated that the prevalence of mastitis was significantly higher in Holstein-Friesian than in indigenous Zebu, in non-lactating cows than lactating cows, in early lactation stage than in the mid-lactation stage, in cows with lesions and/or tick infestation on the skin udder and/or teats than in cows without this factor, and in wet season than in the dry season. The bacterial species that were predominantly isolated from mastitis cases in southern Ethiopia were Staphylococcus aureus, Streptococcus agalactiae, and Escherichia coli.

Currently, programmes in the country are now aimed at encouraging milk production through smallholder and other dairy schemes to increase milk production in different parts of the country. The dairy development schemes consist of upgrading the genetic potential of indigenous cattle through crossbreeding with exotic breeds, and improving the management. Encouraging private dairy sectors may help increase milk production through intensification. Selalle is one of the places where dairying has been encouraged for last three decades. As a result, there are about 40,000 high yielding dairy cows in the area (unpublished data). Wuchale-Jida District is one of the 12 districts of Selalle, which is known for its cattle production and the main source of milk for Addis Ababa, the Capital of Ethiopia. Nevertheless, there is a scarcity of information on the extent of bovine mastitis in the District except cases of clinical mastitis that have been presented to the veterinary clinic for the treatment. Therefore, the importance of initiation of investigation on the extent of both clinical and subclinical mastitis in the area is justifiable. In connection, determination of the predominately incriminated bacteria, and their antibacterial susceptibility patterns are of paramount importance in terms of treatment and control of the disease. Therefore, the present study was designed to determine the prevalence, isolate the dominant bacteria, and establish antibiotic susceptibility patterns of the dominant bacterial isolates in Muke-Turri Town, Wuchale-Jida District of central Ethiopia.

Materials and methods

Description of the study area

The study was conducted in Muke-Turi Town of Wuchale-Jida District, Central
Ethiopia from November 2002 to April 2003. Muke-Turi is located at about 80km North of Addis Ababa. The production system is mainly mixed crop livestock production. Smallholder farmers rear the majority of the farm animals at subsistence level. Farmers owning crossbred cows sell milk to the milk collection units established by a group of interested farmers across the main road. These units process the milk to different milk products and sell the processed milk products at the site, as it is convenient for them. Other groups of farmers sell their milk to private milk processing enterprises, which move to the area to collect milk from individual farmers. Private based intensive dairy production system is also practiced in the area, and it is a more recent development. Moreover, many crossbred cattle have been distributed to farmers by governmental and non-governmental organizations with the objective of increasing milk production in the area.

Study animals and sampling

Muka-Turi was selected because of the existence of large number of crossbred cattle. The list of heads of the household was obtained from the District's Agriculture Department, and was used as sampling frame. Sample size was determined by assuming the expected prevalence to be 34.6%, which was recorded at Repi Dairy Farm. The statistical confidence level was decided to be 95% while the desired precision was 6%. Then sample size calculation was made according to Martin et al. Consequently, a total of 243 lactating cows were included in this study.

Clinical examination

Individual quarters were examined for abnormalities in size, consistency, symmetry, and inflammatory signs by visual inspection and palpation. Swelling (not due to physiological oedema), pain reaction upon palpation, change in consistency of udder, and change in the color and specific gravity of milk, and presence of flakes in the milk were considered as indications of the presence of clinical mastitis. Cows, which did not have clinical mastitis, were subjected to further investigation for subclinical mastitis.

California mastitis test (CMT)

The CMT was used for detecting subclinical mastitis. The procedures and interpretations were according to Quinn et al. Briefly, 2ml milk from each quarter of the udder was added into each of the four wells of the plastic paddle and an equal volume of commercial CMT reagent was added to each well. A gentle swirling was applied to the mixture in horizontal plane. The result of the test was recorded on the basis of gel formation.

Milk sample collection

Milk samples were collected aseptically for bacteriological examination from CMT positive quarters aseptically. During collection, the procedures described by Shroeder were followed. Screw capped test tubes were labeled and used for milk collection. The milk samples were refrigerated at 4°C until (maximum of 48 hrs) being processed for bacteriology.

Bacterial isolation

Enumeration procedures were followed to determine the dominant genera. One ml of sample was taken from each sample after a through mixing by vortex, and serially diluted in four test tubes, each of them containing 9ml of distilled water. Then, 0.1ml of the diluted milk from the 2nd, 3rd, and 4th dilutions were plated on the respec-
tive plate count agar (PC-agar). Thereafter, they were incubated at 37°C for 48 hours. This was followed by picking of 10 to 15 colonies randomly from plates with countable (30-300) colonies. Sub culturing was made in nutrient broth at 37°C for 48 to 72 hours. A loop full of colonies was taken from the broth and streaked on nutrient agar. Further incubation was made at 37°C for 48 to 72 hours. And finally, characterization of the isolates was made on the basis of the morphology and biochemical characteristics.

**Cell morphology and Gram's reaction**

Cell shape and arrangements were examined directly by smearing colonies and examining under microscope using oil immersion. Besides, 4% KOH solution was used for the determination of the Gram's reaction of the isolates. Briefly, a drop of 4% KOH solution was put on grease free slide. Then, a loop-full of colonies were added into the solution and emulsified gently. The loop was raised gently, and observation was made for the trailing mucousy substance. Formation of such substance was indication of Gram negative organism.

**Biochemical test**

For catalase and oxidase tests 3% H2O2 and N’N’N’-tetramethyl-1, 4-phenylene diamine dihydrochloride were used, respectively. Hugh Leifson's medium was used for Oxidation-Fermentation (OF) test of Gram-negative rods. The Baird Parker modification of Hugh-Lieftson’s medium was used for the OF test of Gram positive cocci such as *Staphylococci* and *Micrococci*.

**Spore determination**

Thick smear was prepared, and stained with carbol-fuchsin for 3 minutes. After being washed with tap water, the smear was flooded with 30% aqueous ferric chloride for 2 minutes. This was followed with de-colorization with 5% sodium sulphite solution. Thereafter, it was washed, and counterstained with 1% malachite green. Spores appeared as green while cells appeared as pink.

**Antibiotic susceptibility test**

Single disc diffusion susceptibility test, also termed as Kirby-Bauer method, was utilized to determine the anti-microbial susceptibility patterns of bacteria isolated from cow's milk. The isolates were subjected to disc assay tests using Ampicillin (10µg), Erythromycin (15 µg), Gentamycin (10 µg), Kanamycin (30µg), Nitrofurantoin (300µg), Penicillin G (10IU), Streptomycin (10 µg), and Tetracycline (30µg). The zone of inhibition of the antibiotic disc was measured by holding a ruler on the back of the plate, which was illuminated with reflected light. The value determined was rounded to the nearest whole number millimeter. The measured values (figures) were translated into descriptive terms such as susceptible, intermediate or resistant according to the guidelines of the National Committee for Clinical Laboratory Standard.

**Data analysis**

The herd prevalence was defined as the number of herds with at least one case of mastitis divided by the total number of herds examined. Similarly, the individual animal prevalence was defined as the number of mastitic cows divided by the total number of cows tested. Prevalence was expressed in percentage. The effect of different variables on the prevalence of mastitis was assessed using chi-square (χ²) test. Percentages were used to express the proportion of the isolates of the different
genera of bacteria that were causing mastitis in the area. Besides, the effects of the different antibiotic discs on the isolates were expressed in percentages.

**Results**

**Prevalence**

The herd prevalence of clinical and subclinical mastitis was estimated at 24.14% (35/145), and 42.07% (61/145), respectively. At animal level, the total prevalence (clinical and sub-clinical) mastitis was 48.97% (119/243). When considered separately, the individual animal prevalences of clinical and subclinical mastitis were 15.23% (37/243), and 33.74% (82/243), respectively. Age did not have effect on the prevalence of both clinical ($\chi^2 = 0.18; P=0.914$) and subclinical ($\chi^2=4.09; P=0.13$) mastitis. Similarly, the effect of breed on the prevalence of clinical ($\chi^2=2.51; P=0.11$) and subclinical ($\chi^2=0.96; P=0.32$) mastitis was not statistically significant.

**Isolation of bacteria**

Bacteria belonging to six genera were isolated with *Staphylococcus* (33.33%), and *Micrococcus* (26.67%) dominating the milk flora. The proportion of the dominant bacteria that were isolated from the milk of cows in Muke-Turri is shown in Table 1.

**Antibiotic sensitivity test**

Table 2 shows the antibiotic susceptibility test result of the dominantly (90% of all the isolates) isolated bacteria. Ampicillin and Erythromycin were effective on all the isolates of *Staphylococcus* while Nitrofurantoin and Tetracycline were effective on 80% and 90% of the isolates of *Staphylococcus*, respectively. On the other hand, except Pencillin G, all the tested drugs were effective on all the isolates of *Micrococcus*. Gentamycin, Nitrofurantoin and Streptomycin were effective against all isolates of *Streptococcus*. Erythromycin and Tetracycline were effective on the 80% of the *Streptococcus* isolates. All the isolates that belonged to the Enterobacteriaceae were susceptible to Erythromycin, Gentamycin, Nitrofurantoin, and Streptomycin. Tetracyclin was effective on 75% of the isolates of Enterobacteriaceae. On the other hand, all the dominantly isolated species of bacteria had developed resistance to Pencilllin G. Similarly, both isolates of *Streptococcus* and Enterobacteriaceae had developed resistance to Ampicillin.

**Table 1. Dominant bacteria isolated from clinical/sub clinical mastitic cows in Muke-Turri Town, Central Ethiopia.**

<table>
<thead>
<tr>
<th>Types of dominant isolates</th>
<th>Numbers of mastitic cows affected by isolates</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Staphylococcus</em> spp.</td>
<td>20</td>
<td>33.33</td>
</tr>
<tr>
<td><em>Micrococcus</em> spp.</td>
<td>16</td>
<td>26.67</td>
</tr>
<tr>
<td><em>Bacillus</em> spp.</td>
<td>9</td>
<td>15.00</td>
</tr>
<tr>
<td><em>Streptococcus</em> spp.</td>
<td>5</td>
<td>8.33</td>
</tr>
<tr>
<td>Enterobacteriaceae</td>
<td>4</td>
<td>6.67</td>
</tr>
<tr>
<td><em>Pseudomonas</em> spp.</td>
<td>3</td>
<td>5.00</td>
</tr>
<tr>
<td>Other Gram positive Rods</td>
<td>3</td>
<td>5.00</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>60</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>
Discussion

The total prevalence of mastitis (48.97%) recorded in the present study was found to be similar to that reported earlier\textsuperscript{13, 14, 15}. These authors have reported total prevalence of 53.5%, 53% and 53.35%, respectively, in different parts of the country. However, the total prevalence (63.4%) recorded in Debre Zeit Research Center\textsuperscript{16} was higher than the presently recorded prevalence. The prevalence of subclinical mastitis at animal level was, however, similar to the value (34.6%) reported at Repi Dairy Farm, Addis Ababa 4 but was higher than the prevalence (19%) reported in selected dairy farms nearby Addis Ababa\textsuperscript{17}. The possible causes of such a high prevalence of both clinical and sub-clinical mastitis could be poor milking hygiene, poor housing (which was observed to be wet and muddy) poor nutrition, and insufficient veterinary intervention.

The result of the present study showed that there was no significant difference between crossbred and local cows in mastitis susceptibility. Similar findings were also reported earlier\textsuperscript{14} though significant difference in susceptibility to mastitis between the two breeds was reported in another study\textsuperscript{15}. Though it was stated that high yielding cows are more susceptible to mastitis and teat injuries\textsuperscript{18}, in the present study, the management of the farms might have highly affected the susceptibility of cows to mastitis as both breeds were kept in the same housing, and milked by the same person. The latter increase the chance of transmission of mastitis between the two breeds.

The predominantly isolated genera of bacteria were *Staphylococcus*, *Micrococcus*, *Bacillus*, *Streptococcus*, *Pseudomonas*, *Enterobacteriaceae*, and other Gram-positive rods in decreasing order. Similar genera of bacteria were isolated from cases of mastitis by other workers\textsuperscript{4, 19, 20}. These all-pathogenic bacteria are the primary causes of mastitis. As it can be observed from the results, *Staphylococcus* species was the dominant organism isolated from the study animals. Similarly, *Staphylococcus* species were reported as the

### Table 2. Susceptibility test result of the isolates dominantly (90%) found in milk in Muke-Turri Town, Central Ethiopia.

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Potency of disc</th>
<th>Susceptibility patterns of the dominantly isolated bacteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ampicillin</td>
<td>10μg</td>
<td>*10(#10) 7(7)</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>15μg</td>
<td>10(10) 7(7)</td>
</tr>
<tr>
<td>Gentamycin</td>
<td>10μg</td>
<td>6(10) 7(7)</td>
</tr>
<tr>
<td>Nitrofuantoin</td>
<td>300μg</td>
<td>8(10) 7(7)</td>
</tr>
<tr>
<td>Streptomycin</td>
<td>10μg</td>
<td>1(10) 7(7)</td>
</tr>
<tr>
<td>Pencillin G</td>
<td>10IU</td>
<td>0(10) 1(7)</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>30μg</td>
<td>9(10) 7(7)</td>
</tr>
</tbody>
</table>

# Number of isolates tested;  
*Number of isolates susceptible,
dominant cause of bovine mastitis. Compared to the proportion of *Staphylococcus* species, lower percentage of Streptococcus species were isolated similar to a lower percentage of 6.8% of *Streptococcus* species reported earlier in Kombolcha and its surroundings. It is established that *Staphylococcus* species and many of the *Streptococcus* species, inhabiting the udder and/or on the udder skin, cause contagious mastitis. The transmission of contagious mastitis from infected udder to healthy udder is through milker's hand during milking process and possibly by flies.

Most of the Enterobacteriaceae isolated in this study were from the milk of clinically mastitic cows. Similar findings were reported earlier. According to these authors, approximately 70-80% of the coliform infections become clinically apparent. Similarly, it has been observed that next to *Staphylococcus* species, coliform organisms are commonly isolated from clinical mastitis.

The isolation of *Bacillus* species from mastitic cases has been reported. The proportion of Bacillus species isolated in the present study is closer to the proportion reported in Ethiopia earlier, but higher than that reported elsewhere. Most of the aerobic bacilli are widely distributed in air, water, milk, dust, feces, and other substances. Majority of the aerobic bacilli are saprophytic, and are causes of acute mastitis with or without systemic disturbances.

The result of antibiotic susceptibility test showed that all the dominantly isolated bacteria have developed resistance to Penicillin G. Other authors have also reported similar findings in different parts of the country. Therefore, though the in vitro antibiotic susceptibility test does not exactly reflect the in vivo therapeutic value of the antibiotic, in case of Penicillin G, the in vivo situation in the study area did also reflect the results of in vitro test. On the other hand, Ampicillin and Erythromycin were effective against the dominantly prevailing *Staphylococcus* species. While Gentamycin, Nitrofurantoin and Streptomycin were effective against all isolates of *Streptococcus* species. Similarly, all isolates that belong to the Enterobacteriaceae were susceptible to Erythromycin, Gentamycin, Nitrofurantoin, and Streptomycin.

Based on the results of this study, it is recommended that in order to reduce mastitis prevalence, treatment of should be based on synergistic effect of different drugs so as to combat the major mastitis-causing microorganisms. The use of Pencillin G for the treatment of mastitis should be discouraged as the dominant mastitis causing bacteria have developed resistance to it. Regular drug sensitivity test should be conducted so as to select effective drug(s).

**Acknowledgement**

We would like to acknowledge the Institute of Pathobiology, and the Research and Publication Office of the Addis Ababa University for their financial support to run this project.

**References**


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AGE AT FIRST CALVING, CALVING INTERVAL AND MILK YIELD PERFORMANCE OF FRIESIAN-BORAN CROSSBRED CATTLE AT CHEFFA STATE FARM, WOLLO, ETHIOPIA

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AGE AU PREMIER VELAGE, INTERVALLE DES VELAGES ET RENDEMENT EN LAIT DU CROISEMENT FRISON X BORAN A LA FERME D'ETAT DE CHEFFA A WOLLO EN ETHIOPIE

Résumé

Les rapports sur 602 vaches croisées Frison x Boran, élevées à la ferme d'Etat de Cheffa en Ethiopie, ont été examinés en vue de comparer l'âge au premier vêlage, l'intervalle des vêlages, la durée de la lactation et la production de lactation et ce, pour interpréter l'effet des taux d'hérédité ($\frac{1}{2}$, $\frac{3}{4}$, $\frac{7}{8}$ et $\geq \frac{15}{16}$ Frison), le nombre de vêlages (1 à 9 +) et la saison (courte pluie, longue pluie, saison sèche). L'âge au premier vêlage (n = 505) variait entre 32,9 mois pour le groupe ayant un taux d'hérédité $\frac{1}{2}$ et 37,7 mois pour le groupe à $\frac{15}{16}$ et plus. Le croisement, la saison et le nombre de vêlages affectaient beaucoup ce paramètre. L'intervalle des vêlages (n = 1.644) oscillait entre 417 jours pour le groupe ayant un taux d'hérédité $\frac{1}{2}$ et 457 jours pour le groupe à $\frac{15}{16}$ et plus, mentionné dans la présente étude. Le taux de croissement et le nombre de vêlages avaient un effet significatif sur l'intervalle des vêlages. La durée moyenne de la lactation dans l'ensemble (n = 2049) et la production de lactation (n = 2.049) étaient de 287,6 ± 1,5 jours et 3.019 ± 24 kg respectivement. La production laitière moyenne/jour pendant la durée de la lactation et la période inter-vêlage était de 10,4 ± 0,06 et 7,6 ± 0,07 kg respectivement. La saison et le nombre de vêlages affectaient beaucoup les deux variables, mais tous les animaux croisés étaient similaires quant au rendement laitier moyen/jour. D'après les résultats, il y a une faible performance de production et de reproduction à mesure qu'augmentait le taux de croissement.

Mots-clés: Boran, Frison, hérédité, nombre de vêlages, saison.

Summary

The records of 602 various Friesian x Boran crossbred cows maintained at Cheffa state farm, Ethiopia were analysed to compare age at first calving, calving interval, lactation length and lactation yield to interpret the effect of the levels of inheritance ($\frac{1}{2}$, $\frac{3}{4}$, $\frac{7}{8}$ and $\geq \frac{15}{16}$ Friesian), parity (1 to 9*), and season (short rainy, long rainy and dry). Age at first calving (n=505) ranged from 32.9 for $\frac{1}{2}$ breed group to 37.7 months for $\frac{15}{16}$ and above grades. Breed group, season and parity significantly affected this parameter. Calving interval (n=1644) ranged from 417 days for the half-breed to 457 days for the $\frac{15}{16}$ and above included in this study. Exotic breed blood level and parity had significant effect on calving interval. The overall average lactation length (n=2049) and lactation yield (n=2049) were 287.6±1.5 days and 3019±24 kg, respectively. The daily average milk production for the lactation and intercalving period were 10.4±0.06 and 7.6±0.07kg, respectively. Season and parity significantly affected both variables, but all the breed groups were similar in daily average lactation yield. The results showed that there is low-level of reproductive and productive performance as the exotic breed blood level increased.

Key words: Boran, Friesian, Inheritance, Parity, Season.

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Introduction

Self-sufficiency in beef and milk yield is not yet attained in Ethiopia despite the fact that the country possesses over 29.8 million cattle\(^1\). The foundation of modern dairy development was laid down over four decades. During this period, crossbreeding of cattle in ranches and commercial dairy farms were established in various parts of the country to improve the local cattle. Performance studies in some locations indicated encouraging trends especially with the F1 cows\(^2\)–\(^5\). The crossbreeds calved earlier, yielded more milk, and had shorter calving intervals than the indigenous stock. However, the results from high grades are inconsistent and unfavourable in most locations. So far, the evaluations were limited to state farms located mainly in higher altitude where the climate is suitable for dairy production. Lowland areas are characterised by relatively high temperatures, low rainfall, and high disease and parasite incidences. The purpose of this study was to evaluate age at first calving, calving interval and milk yield performances of various Friesian-Boran crosses based on data collected over 20 years at Cheffa state farm in Ethiopia.

Materials and Methods

The study was conducted at Cheffa state farm situated at 10° 55' N latitude and 39° 47' E longitude at an altitude of 1490 meters above sea level. The farm area is classified under Kolla (hot temperate) agro-ecology. The three defined seasons based on rainfall distribution are: short rainy season (February to May); long rainy season (June to September) and dry season (October to January). The annual rainfall average is 960 mm. The average maximum and minimum temperatures from 1975 to 1986 were 30.2 and 13.6 °C, respectively with mean annual average of 22°C. The average relative humidity is about 19.5%.

The herd was established in 1976 from Boran dams, pure Holstein-Friesian bulls and cows of various breed groups of Holstein-Friesian origin. Records of 602 cows from 1976 to 1997 were used for this study. The grazing area is about 400 hectares (ha) and animals graze in-groups. The pastureland management is not consistent and is affected by water logging, infested with noxious weeds and unpalatable annuals. Hay was made from 75 ha of land. In some years due to water logging and labour problem, the size of harvest was reduced. Alfalfa was the main green feed supplied to the animals. The cut and wilted alfalfa was transported from the site that is 7 km away. Concentrate was prepared at the farm by mixing 30% maize, 68% noug cake (Guizota Abyssinica), 1% bone meal and 1% salt. Pregnant cows and in-calf heifers were fed 3 kg of concentrate per day for the last 45 days before calving. Lactating cows were supplemented 0.5 kg concentrate per litre of milk for half of the total milk produced. Calves were separated from their dam immediately after birth and fed with colostrum for two days and whole milk for 45 days. Small quantities of concentrate were provided after 45 days.

Vaccination against rinderpest, CBPP, anthrax, blackleg and foot and mouth disease were given. Animals were dewormed and treated for internal and external parasites, respectively. Treatment for cowdriosis, streptotrichosis, mastitis, babesiosis, anaplasmosis, diarrhoea and other incidences were done. Animals in heat were detected by morning observation, breeding calendar and from
Table 1: Least squares means (S.E.) of age at first calving by breed group and season of birth.

<table>
<thead>
<tr>
<th>Source</th>
<th>n</th>
<th>Mean ± S.E.(months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>505</td>
<td>36.0 ± 0.3</td>
</tr>
<tr>
<td>Level of Holstein F. blood</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2</td>
<td>69</td>
<td>32.9 ± 0.6&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>3/4</td>
<td>220</td>
<td>36.4 ± 0.5&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>7/8</td>
<td>167</td>
<td>38.5 ± 0.6&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>15/16 and above</td>
<td>49</td>
<td>37.7 ± 1.1&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Season of birth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short rainy</td>
<td>139</td>
<td>35.7 ± 0.6&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Long rainy</td>
<td>152</td>
<td>36.0 ± 0.6&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>Dry</td>
<td>214</td>
<td>37.4 ± 0.5&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Within variable groups, means followed by the same subscripts do not differ significantly (P < 0.05).

Table 2: Least squares means (S.E.) of calving interval by breed group, parity and season of calving.

<table>
<thead>
<tr>
<th>Source</th>
<th>n</th>
<th>Mean ± S.E (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>1644</td>
<td>450.2 ± 3.8</td>
</tr>
<tr>
<td>Level of Holstein F. blood</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2</td>
<td>635</td>
<td>417.7 ± 4.8&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>3/4</td>
<td>731</td>
<td>431.0 ± 5.7&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>7/8</td>
<td>206</td>
<td>457.9 ± 13.1&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>15/16 and above</td>
<td>72</td>
<td>474.6 ± 25.0&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Parity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>418</td>
<td>509.0 ± 9.0&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>2</td>
<td>322</td>
<td>466.1 ± 8.7&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>3</td>
<td>270</td>
<td>449.3 ± 9.4&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>4</td>
<td>204</td>
<td>435.5 ± 8.0&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td>5</td>
<td>147</td>
<td>435.1 ± 8.5&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td>6</td>
<td>104</td>
<td>453.8 ± 13.9&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>7</td>
<td>75</td>
<td>401.1 ± 7.2&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>8</td>
<td>50</td>
<td>418.3 ± 15.9&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td>9+</td>
<td>54</td>
<td>439.2 ± 20.9&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td>Season of calving</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short rainy</td>
<td>476</td>
<td>450.5 ± 7.2</td>
</tr>
<tr>
<td>Long rainy</td>
<td>484</td>
<td>451.4 ± 7.2</td>
</tr>
<tr>
<td>Dry</td>
<td>684</td>
<td>434.0 ± 5.5</td>
</tr>
</tbody>
</table>

Within variable groups, means followed by the same subscripts do not differ significantly (P < 0.05).
reports of the guard during the grazing time and mated naturally. Culling was based on low milk production, low reproductive rate, old age and serious diseases. Most management activities, however, were done irregularly and hand milking was done twice daily at 5:00 am and 4:00 pm. Lactating cows were offered part of the concentrate during milking. Measuring of the milk produced by each cow was done immediately after each milking.

Calving interval (CI) was calculated for calvings that culminated in normal or stillbirths (greater than 260 days of gestation). Breed groups included in the study were 1/2, 3/4, 7/8 and 15/16 and above of Friesian inheritance. The other fixed effects considered were parity number (1 to 9+), season (3) and year (20). A total of 505, 1644 and 2049 records were analysed for AFC, CI & DMIC and LY, respectively. Daily milk yield for the intercalving period is obtained by dividing total milk yield to the calving interval. The analyses were carried out using Least Squares and Maximum Likelihood procedures. Linear contrasts of least-squares means were computed to detect the significance of differences within groups for all characters where the difference was significant in the analysis of variance.

Table 3 Least squares means (S.E.) of lactation length and lactation milk yield by breed group, parity and season of calving.

<table>
<thead>
<tr>
<th>Source</th>
<th>n</th>
<th>Length (days)</th>
<th>Lactation yield (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean ± S.E.</td>
<td>Mean ± S.E.</td>
</tr>
<tr>
<td>Overall</td>
<td>2049</td>
<td>287.6 ± 1.5</td>
<td>3019 ± 24</td>
</tr>
<tr>
<td>Level of Holstein F. blood</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2</td>
<td>727</td>
<td>284.4 ± 2.2</td>
<td>2978 ± 39.9</td>
</tr>
<tr>
<td>3/4</td>
<td>893</td>
<td>288.4 ± 2.2</td>
<td>3043 ± 35.1</td>
</tr>
<tr>
<td>7/8</td>
<td>324</td>
<td>270.0 ± 4.8</td>
<td>2780 ± 63.7</td>
</tr>
<tr>
<td>15/16 and above</td>
<td>105</td>
<td>280.0 ± 6.7</td>
<td>2924 ± 105</td>
</tr>
<tr>
<td>Parity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>469</td>
<td>288.4 ± 3.3</td>
<td>2572 ± 46.6</td>
</tr>
<tr>
<td>2</td>
<td>372</td>
<td>283.2 ± 3.4</td>
<td>2765 ± 56.5</td>
</tr>
<tr>
<td>3</td>
<td>311</td>
<td>286.1 ± 3.3</td>
<td>3050 ± 58.4</td>
</tr>
<tr>
<td>4</td>
<td>251</td>
<td>285.2 ± 4.0</td>
<td>3078 ± 67.2</td>
</tr>
<tr>
<td>5</td>
<td>193</td>
<td>284.8 ± 4.0</td>
<td>3128 ± 77.7</td>
</tr>
<tr>
<td>6</td>
<td>152</td>
<td>285.9 ± 5.2</td>
<td>3141 ± 88.7</td>
</tr>
<tr>
<td>7</td>
<td>108</td>
<td>285.0 ± 6.4</td>
<td>3066 ± 104</td>
</tr>
<tr>
<td>8</td>
<td>79</td>
<td>265.5 ± 10.0</td>
<td>2809 ± 137</td>
</tr>
<tr>
<td>9+</td>
<td>114</td>
<td>262.1 ± 7.7</td>
<td>2773 ± 106</td>
</tr>
<tr>
<td>Season of calving</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short rainy</td>
<td>623</td>
<td>278.8 ± 2.9</td>
<td>2944 ± 45.7</td>
</tr>
<tr>
<td>Long rainy</td>
<td>610</td>
<td>280.4 ± 2.7</td>
<td>2859 ± 44.0</td>
</tr>
<tr>
<td>Dry</td>
<td>816</td>
<td>282.8 ± 2.2</td>
<td>2991 ± 36.6</td>
</tr>
</tbody>
</table>

Within variable groups, means followed by the same subscripts do not differ significantly (P < 0.05).
**Results**

The mean AFC for 1/2 breeds was significantly lower than the rest of the crosses (Table 1). The breed groups 3/4, 7/8 and 15/16 and above required 3.5, 5.6 and 4.8 more months to give the first calf than the 1/2 breeds. Season of birth had a significant effect on the AFC. Animals born during the short rainy season calved 1.7 months younger in age than those born in the dry seasons.

The overall mean for CI obtained was 450.2 ± 3.8 days. There was no significant difference in CI between 1/2 and 3/4 groups but higher grades had significantly longer CI. Parity of dam had a significant (P<0.01) effect on this variable, and the length of the CI decreased as the age of the cow increased up to the third parity. Beyond the third parity, the trend was not uniform. The longest CI of 509.0 ± 9.0 was observed for primiparous cows and the shortest CI of 401.1 ± 7.2 was for the seventh parity. There was no significant effect of season of calving on calving interval (Table 2).

The overall mean lactation length and lactation yield were 287.6 ± 1.5 days and 3019.0 ± 24 kg, respectively. Breed groups and parity significantly affected lactation length and lactation yield, but season of birth was not a significant factor (Table 3).

<table>
<thead>
<tr>
<th>Source</th>
<th>n</th>
<th>DMYL Mean ± S. E.</th>
<th>n</th>
<th>DMYIC Mean ± S. E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>2049</td>
<td>10.4 ± 0.06</td>
<td>1644</td>
<td>7.6 ± 0.07</td>
</tr>
<tr>
<td>Level of Holstein F. blood</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2</td>
<td>727</td>
<td>10.3 ± 0.10</td>
<td>635</td>
<td>7.8 ± 0.11&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>3/4</td>
<td>893</td>
<td>10.4 ± 0.08</td>
<td>731</td>
<td>7.9 ± 0.10&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>7/8</td>
<td>324</td>
<td>10.0 ± 0.15</td>
<td>206</td>
<td>7.2 ± 0.19&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>15/16 and above</td>
<td>105</td>
<td>10.3 ± 0.27</td>
<td>72</td>
<td>7.5 ± 0.37&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td>Parity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>469</td>
<td>8.8 ± 0.11&lt;sup&gt;c&lt;/sup&gt;</td>
<td>418</td>
<td>5.8 ± 0.13&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>2</td>
<td>372</td>
<td>9.6 ± 0.14&lt;sup&gt;b&lt;/sup&gt;</td>
<td>322</td>
<td>6.8 ± 0.15&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>3</td>
<td>311</td>
<td>10.4 ± 0.14&lt;sup&gt;a&lt;/sup&gt;</td>
<td>270</td>
<td>7.7 ± 0.17&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td>4</td>
<td>251</td>
<td>10.6 ± 0.16&lt;sup&gt;a&lt;/sup&gt;</td>
<td>204</td>
<td>7.9 ± 0.19&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td>5</td>
<td>193</td>
<td>10.8 ± 0.19&lt;sup&gt;a&lt;/sup&gt;</td>
<td>147</td>
<td>8.0 ± 0.23&lt;sup&gt;abc&lt;/sup&gt;</td>
</tr>
<tr>
<td>6</td>
<td>152</td>
<td>10.8 ± 0.20&lt;sup&gt;a&lt;/sup&gt;</td>
<td>104</td>
<td>8.0 ± 0.26&lt;sup&gt;abc&lt;/sup&gt;</td>
</tr>
<tr>
<td>7</td>
<td>108</td>
<td>10.6 ± 0.25&lt;sup&gt;a&lt;/sup&gt;</td>
<td>75</td>
<td>8.2 ± 0.31&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>8</td>
<td>79</td>
<td>10.3 ± 0.29&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>50</td>
<td>8.6 ± 0.38&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>9+</td>
<td>114</td>
<td>10.3 ± 0.24&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>54</td>
<td>7.4 ± 0.37&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Season of calving</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short rainy</td>
<td>623</td>
<td>10.3 ± 0.11&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>476</td>
<td>7.6 ± 0.13&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>Long rainy</td>
<td>610</td>
<td>10.0 ± 0.11&lt;sup&gt;b&lt;/sup&gt;</td>
<td>484</td>
<td>7.4 ± 0.13&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Dry</td>
<td>816</td>
<td>10.4 ± 0.09&lt;sup&gt;a&lt;/sup&gt;</td>
<td>684</td>
<td>7.8 ± 0.11&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Within variable groups, means followed by the same superscripts do not differ significantly (P < 0.05).
Significantly shorter lactation lengths were observed after the seventh calving. The performance of 7/8 grade crosses was significantly lower than that of 1/2 or 3/4 grades. The yield obtained for 7/8 and high grades were similar. The highest total yields were obtained on the fifth and sixth lactations.

The overall means for DMYL and DMIC were 10.4 ± 0.06 and 7.6 ± 0.07 kg, respectively (Table 4). Parity and season significantly affected DMYL and DMIC. Breed group was significant for daily intercalving milk yield. Higher DMIC was obtained for 50 and 75% crosses. As exotic blood level increased, both average values decreased. The lowest average yields were observed for first calvers and 7/8 crosses. There was no significant difference in DMYL for cows beyond the third parity. As parity increased, so did per day milk yield for CI period except the ninth and above parity cows. Season had a significant effect on the DMYL and DMIC. Cows that calved during the dry season had higher DMYL than those calved during the long rainy season.

Year had affected significantly all traits and contributed about 50, 28, 22, and 31% of total variance of AFC, CI, DMIL and DMYIC, respectively.

Discussion

In this investigation, the half breeds had significantly lower AFC and it is less than the reported values for 50% Friesian crosses in Ethiopia. However, 50% Friesian either with Arsi or with Zebu calved at still younger age.

The superiority of 50% crosses over higher grades has also been reported in Ethiopia and elsewhere in tropical countries. The increased AFC observed in heifers with and more than 3/4 of exotic inheritance could be explained by increased managerial and feeding demand of higher grades during their early growth period before conception. Under same management and other productivity indices are close.

In some studies, season affected the AFC of 50% Friesian crosses and not of 75% Friesian crosses. A non-significant effect of season on AFC was also reported. The significant effect of year on AFC by and large depended on feed, rainfall, disease and parasitic burden during the period of infancy to successful conception.

The overall CI observed was 450 ± 3.8 days. The purebred Boran had almost similar calving interval of 465, 470 and 435 days in Ethiopian farms. Longer calving intervals at Cheffta farm for higher grades (474 days) could be related to the repeat breeders. The current result obtained for 1/2 bred (417.7 days) is more than the values of earlier report. However, it is in agreement with recent estimates for the similar grades of cattle in Ethiopia. The increasing length of calving interval with increasing level of exotic inheritance observed in the present study is in line with the report for 3/4 Ayrshire and 1/4 Sahiwal crosses.

Non-significant effect of season of calving on CI as observed in present investigation (i.e. non-seasonality of reproduction) was also reported for Boran and other indigenous crossbreeds. The significance of the year effect in the length of intercalving period could have been related to changes in the climatic conditions and availability of feed over different years. The high CI in some years may be due to deterioration of management, lack of strict follow up of breeding cows and timely mating of in-heat
The overall lactation length estimated in this study was 287.6 days and the half bred had 284.4 days. These values are longer than the lactation length of pure Boran breed but shorter than the higher level of Friesian crosses with Ethiopian indigenous breeds\textsuperscript{5-7, 9, 10}. However, higher exotic crosses had less lactation yield presumably due to higher feed and management requirements.

In the present study, breed groups had similar milk yield except the 7/8 blood level. The average milk production at Cheffia farm for similar blood group was much higher compared to earlier reports for 50 and 75\% Friesian crosses\textsuperscript{5-7}. The average lactation milk yield (3019 kg) was less than the values of 3876 and 3357 kg reported for 7/8 and above and pure Friesian\textsuperscript{11-20}. However, higher milk yield in both reports may have been due to longer lactation lengths (351 and 331 days, respectively).

The significant parity effect on lactation yield meant that yield increased from the first lactation (2572 kg) to the second (2765 kg) and third lactations (3050 kg). This was then up to the sixth lactation. A similar trend has also been reported elsewhere\textsuperscript{21-23}. This might be due to the decline of management and change in climatic conditions with age since year affected this and other variables significantly. However, it was found that lactation number (age) had no influence on 300 days yield, peak yield, persistency index and lactation length\textsuperscript{17, 24}.

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The authors would like to thank the management of Cheffia state farm for providing the data. We are highly indebted to Dr. Azage Tegegne for reviewing the manuscript. We also thank Dr. Fekadu Kebede for providing unpublished data on prevalence of mastitis in the area.

References


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ASSESSMENT OF THE EFFICIENCY OF DAIRY COW EVALUATION METHODS

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P.O. Box 29053, Nairobi, Kenya

COMPARAISON DE L'EFFICACITE DES METHODES D'EVALUATION DES VACHES LAITIERES

Résumé

Au total, 956 vaches frisonnes pour lesquelles on détenait de nombreux rapports de lactation sur une période de 22 ans (1966 à 1987) étaient évaluées génétiquement en calculant quatre différents indices pour chaque animal. Les quatre indices étaient les suivants : la moyenne corrigée des moindres carrés (MCMC), la capacité de potentiel productif réel (CPPR), l'indice de potentiel génétique (IPoG) et l'indice de prévision génétique (IPrG). Deux combinaisons de paramètre d'hérédité (h² = 0,20) et de répétabilité (t = 0,43) produites étaient issues des données ; et h² = 0,25 et t = 0,45, les moyennes des estimations obtenues de la documentation étaient utilisées. Les corrélations entre les classements des vaches à l'aide des quatre indices ainsi calculés ont montré que les classements par MCMC, CPPR et IPoG étaient similaires ; en revanche, il y avait une nette différence pour IPrG. Par ailleurs, l'efficacité relative des indices a identifié IPrG comme étant l'indice approprié pour la sélection des vaches laitières.

Summary

A total of 956 Friesian cows with multiple lactation records, spanning a period of 22 years (1966 to 1987), were genetically evaluated by computing four different indices for each animal. The indices were Adjusted Least Square Mean (ALSM), Expected Real Producing Ability (ERPA), Expected Breeding Value (EBV) and Predicted Breeding Value (PBV). Two parameter combinations of heritability (h² = 0.20) and repeatability (t) = 0.43, generated were from the data, and h² = 0.25 and t = 0.45, averages of estimates obtained from literature were employed. The results from using the two sets of parameters did not change the final outcomes. The correlations between the cow rankings by the four indices so computed showed that the rankings by ALSM, ERPA and EBV were similar, but markedly different from that by PBV. On the other hand, the relative efficiencies of the indices identified PBV as the most appropriate index for the selection of dairy cows.

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Introduction

Although the greater part (60-70%) of the genetic change in milk production accrues from the selection of progeny - tested bulls\(^8\), several studies have shown the importance of efficient cow selection. For instance, it has been observed that 20-49% of the genetic improvement or economic returns are from the selection of bull-dams\(^1\).\(^2\).\(^3\).\(^4\). In addition, the loss of gain attributed to a somewhat less effective dam-dam selection is partly responsible for the lower (1%) realized annual genetic gain in milk production than is theoretically (2%) possible\(^6\). Therefore, meaningful selection of cows can only be achieved through effective cow evaluation. Currently, statistical methods, notably the BLUP with animal model, are available for such evaluations. In Kenya, application of BLUP is largely constrained by the low level of dairy recording, which currently covers less than 1% of the recordable cows\(^5\).\(^7\). This limitation is more pronounced on smallholder farms, which now dominate the industry. Therefore, one of the short-term solutions to this problem is to introduce simple indices, which can use the limited dairy records, commonly found on the farms, for within-herd cow evaluation. The purpose of this paper was to assess the efficiencies of the four methods of evaluating the genetic merit of dairy cows and identify the most efficient and appropriate method for intra-herd application.

Materials and Methods

The data used in this study were lactation records of Friesian cows from Sasumua Estate, a large-scale dairy farm located at the bottom of Rift Valley in Kenya, covering the period 1966 to 1986. Structure of the data is set out in Table 1. The cows were grazed on natural pastures but were given supplementary feeds mainly consisting of hay, during dry period. Mineral salt and water were given *ad libitum*. The cows were hand milked twice daily (morning and evening) and the yield recorded at each milking.

Three calving seasons: Season 1: Long rains (March - May), Season 2: Short rains (October - November) and Season 3: Dry period (rest of the year) were defined based on monthly rainfall data. All lactations which lasted for at least 120 days and were

<table>
<thead>
<tr>
<th>Table 1: Form and structure of the data</th>
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<tbody>
<tr>
<td><strong>Variable</strong></td>
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<td>----------------</td>
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<tr>
<td>Total lactation records</td>
</tr>
<tr>
<td>Cows*</td>
</tr>
<tr>
<td>No of sires</td>
</tr>
<tr>
<td>Seasons</td>
</tr>
<tr>
<td>Parities</td>
</tr>
</tbody>
</table>

*Cows were daughters of the sires in the data set.
completed normally were included in the analysis, while incomplete short lactations (less than 120 days) were excluded. The lactation records were standardized to 305-day yields (305-d MY) by regressing the actual milk yield (AMY) on lactation length (LL). That is,

$$305\text{-d MY} = (\text{AMY/LL}) \times 305\text{kg}$$

The adjustment assumed that all cows had the genetic potential to produce milk for at least 305-days.

**Statistical Analysis**

Mixed Model Least-squares and Maximum Likelihood computer programmes was used to estimate heritability, repeatability, sire transmitting abilities, cow solutions and least squares constants by fitting two mixed models to the records.

**Model 1:**

$$Y_{ijklm} = \mu + B_i + D_j + P_k + C_{lm} + e_{ijklm}$$

where,

- $Y_{ijklm}$ = the $n$th 305-day milk yield (kg) record of the $m$th cow, sired by the $i$th bull, the cow calved in the $k$th parity, in the $j$th season of the $i$th year.
- $\mu$ = the underlying constant common to all records.
- $B_i$ = the fixed effect of the $i$th year of calving
- $D_j$ = the fixed effect of the $j$th season of calving
- $P_k$ = the fixed effect of the $k$th parity
- $C_{lm}$ = random sire effect, common to all daughters of the $m$th sire, with mean zero and variance $\sigma_s^2$
- $C_{lm}$ = random effect, common to all records of the $M$th daughter of the $i$th sire, with mean zero and variance $\sigma_s^2$
- $e_{ijklm}$ = a random error effect, associated with each observation with mean zero and variance $\sigma_e^2$

**Model 2:**

$$Y_{ijklm} = \mu + B_i + D_j + P_k + C_i + e_{ijklm}$$

where,

- $Y_{ijklm}$ = the 305-day milk yield (kg) record of the $i$th cow, calving in the $l$th parity, in the $j$th season of the $i$th year.
- $\mu$, $B_i$, $D_j$ and $P_k$ were as described in model 1.
- $C_i$ is the random effect common to all records of the $i$th cow with mean zero and variance $\sigma_c^2$

$$e_{ijklm}$$ = the random error effect associated with mean zero and variance $\sigma_e^2$

**Construction of Cow Indices**

Four different cow indices were computed as follows:

**Adjusted Least Square Mean**

All the lactation records were first adjusted additively for the year of calving and parity using the constant estimates from Model 1. Thus,

$$\hat{Y}_{ilm} = Y_{ijklm} - \hat{B}_i - \hat{D}_j - \hat{P}_k$$

where, $Y_{ilm}$ is the adjusted 305-day milk yield, while the rest of the terms were as described in Model 1. The Adjusted Least Square Means (ALSM) for individual cows were derived from the adjusted records of individual cows.

**Expected Real Producing Ability**

Expected Real Producing Ability (ERPA) was computed for each cow using all records available as follows:
ERPA = \bar{P} + \{nt/[1+(n-1)t]\}(\bar{X}-\bar{P})

where,
\[ \bar{P} = \text{the mean 305-day milk yield of the herd or population, i.e. the mean across herds} \]
\[ n = \text{the number of lactation records of a particular cow} \]
\[ t = \text{the repeatability of 305-day milk yield} \]
\[ \bar{X} = \text{the cow's Adjusted Least Squares mean of records} \]

ERPA is the expected real performance of the evaluated animal and can be used for culling of cows both within herds. The index may also be used to select cows across herds if population mean is known and the effect due to herds is adjusted for.

**Expected Breeding Value**

Expected Breeding Value (EBV) was again computed as

\[ E\bar{B}V = \bar{P} + \{n\bar{h}^2 \}/\{1+(n-1)t]\}*(\bar{X}-\bar{P}) \]

Where, EBV, \( \bar{P} \), \( n \), \( \bar{h} \) and \( \bar{X} \) were as described before, \( h^2 \) is the heritability of 305-day milk yield.

**Predicted Breeding Value**

The predicted Breeding Value (PBV) of a cow was calculated as the sum of her sire's estimated transmitting ability (ETA) and the fraction of her "cow solution" that was genetic. Thus,

\[ \text{PBV} = \text{Sire ETA} + 3k_2/k_1 \text{* cows solution} \]

where, quotient \( 3k_2/k_1 \) was equivalent to 0.75 h^2 / [(r - 0.25h^2) and represented the fraction of the cow solution/variance that was genetic]. PBV predicted the breeding value of the cow and could be used for both intra and inter-herd cow selection.

**Rank Correlations**

The evaluated cows were ranked in descending order, depending on their respective efficiencies of the indices; ALSM, ERPA EBV and PBV. A rank correlation test was then performed using the formula,

\[ p = 1 - 6 \sum d^2 / [m (m^2 - 1)] \]

where, \( p \) = the rank correlation coefficient, \( d^2 \) = the squared rank difference, and \( m \) = the total number of ranked cows.

**Relative Efficiency of Index**

The relative efficiencies of the EBV and PBV as cow genetic indices were derived correlations. Thus,

\[ r_{ia} = \sigma_i / \sigma_a \]

where, \( r_{ia} \) is the relative efficiency of the index.

**Table 2:** Rank correlations of the cows based on the indices computed using the parameter estimates of this study

<table>
<thead>
<tr>
<th>Index</th>
<th>ERPA</th>
<th>EBV</th>
<th>PBV</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALSM</td>
<td>0.99(0.99)</td>
<td>0.99(0.99)</td>
<td>0.74(0.80)</td>
</tr>
<tr>
<td>ERPA</td>
<td>-</td>
<td>1.00(1.00)</td>
<td>0.74(0.80)</td>
</tr>
<tr>
<td>EBV</td>
<td>-</td>
<td>-</td>
<td>0.74(0.80)</td>
</tr>
</tbody>
</table>

ALSM = Adjusted Least Square Mean; ERPA = Expected Real Producing Ability; EBV = Expected Breeding Value and PBV = Predicted Breeding Value.

( ) = Cow rankings by indices computed using the average parameters derived from the literature.
Results and Discussions

Rank Correlations

Table 2 shows the correlations between the cow rankings according to the four indices with parameter combinations of $h^2 = 0.20$ and $t = 0.43$ and $h^2 = 0.25$ and $t = 0.45$, where $h^2$ and $t$ are heritability and repeatability.

With the parameter combination of $h^2 = 0.20$ and $t = 0.43$, ALSM has the same rank correlation of 0.99 separately between ERPA and EBV, while ERPA and EBV had, as expected, a rank correlation of 1.00. On the other hand, PBV had a rank correlation of 0.74 between ALSM, ERPA or EBV. These results parallel those obtained when the average values of heritability (0.25) and repeatability (0.45) were used in computing the indices. Worth noting, however, is the fact that the higher rank correlation of 0.80 between PBV and ALSM, ERPA or EBV reflected similarity in cows' ranking by the four indices. As would be expected, the rank correlation of 0.99 between ALSM and ERPA or EBV agrees with previous studies and indicates that the three indices are quite similar and generally give the same ranking of cows.

The rank correlation of 1.00 between ERPA and EBV clearly indicates that both indices rank cows similarly. ERPA and EBV are, therefore, equally efficient in cow selection and either of them may be used, depending on ease of application. Finally, the rank correlations of 0.74 between PBV and ALSM, ERPA or EBV do, on the other hand show that cow ranking by PBV is strikingly different from that by any of the other three indices and is the "index" of choice.

Relative Efficiency of Index

Since $\sigma_i$ is the same for the index, the magnitude of the sample standard deviations of the indices ($\sigma_i$), which were estimators of their respective $\sigma_i$ values, were indicators of their relative efficiencies. Therefore, as the index deviation ($\sigma_i$) increased, the correlation between the index and the true breeding value of the animal were high and approached unity. Because of the linear relationship, the index with a larger standard deviation would be more accurate. The relative efficiencies of the ALSM and ERPA indices were, on the other hand, deduced from their degree of similarity in ranking the cows with EBV as indicated by their respective correlations.

The standard deviations (kg) of the EBV and PBV indices were $235.16\pm7.81$ and $331.23\pm11.00$ (for $h^2 = 0.20$ and $t = 0.43$), and $287.23 \pm 9.54$ and $357.93 \pm 11.89$ (for $h^2 = 0.25$ and $t = 0.45$), respectively. This indicates, as expected, that PBV is more efficient than EBV as a cow genetic index.

Using the ranking correlations (Table 2), it can be deduced that ERPA would be as efficient as EBV in cow selection. However, EBV reflects the cow's breeding value and may be used for cow selection both within and between herds. Thus, it is considered to be a better index than ERPA because the deviation of the cow's ALSM is weighted by heritability rather than repeatability. ALSM would be 1% less efficient.

Conclusion

The results of this study have shown, as would be expected, that PBV was the
most efficient and, therefore, the most appropriate index among the four cow evaluation indices studied. The PBV resulted in the largest deviation, and, by implication, the highest correlation (r_\text{PBV}) between itself as an index (I) and the actual breeding value (A). This was because, compared to other indices, it combined the most sources of information. The multiple sources of information, as used in PBV, have implications on recording and infrastructural development for Kenya.

References


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SEASONAL AND SPECIES VARIATIONS IN ERYTHROCYTES OSMOTIC FRAGILITY OF INDIGENOUS POULTRY SPECIES IN ZARIA, NORTHERN GUINEA SAVANNAH ZONE OF NIGERIA

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³National Animal Production and Research Institute, Shika, Ahmadu Bello University University, Zaria, Nigeria

EFFETS DES VARIATIONS DES SAISONS ET DES ESPECES SUR LA RESISTANCE GLOBULAIRE DES VOLAILLES LOCALES A ZARIA DANS LA ZONE DE SAVANE GUINEENNE DU NORD DU NIGERIA

Résumé

Au total, cent-vingt prélèvements de sang ont été faits à des poulets, des pintades, des canards et des pigeons apparemment en bonne santé, afin de déterminer la résistance globulaire (RG). La RG était déterminée spectrophotométriquement dans l'eau physiologique hypotonique pendant l'harmattan, la saison chaude et la saison des pluies. La RG était très forte chez les poulets et les pintades avec une résistance minimum et maximum allant de 0,65 à 0,75% et 0,25 à 0,35% de concentrations de chlorure de sodium (% NaCl) respectivement. La résistance la plus faible était observée chez les pigeons avec une résistance minimum et maximum qui variaient entre 0,45 - 0,65% et 0,15 - 0,25% de concentrations de NaCl respectivement. Le fragiligramme dérivatif du poulet, de la pintade et du canard était unimodal, tandis que celui du pigeon était bimodal. Chez toutes les espèces de volaille locale, les érythrocytes étaient plus faibles à la lyse osmique pendant la saison chaude par rapport aux deux autres saisons. On en a conclu que durant la saison chaude et sèche, le stress hypotonique des érythrocytes devrait être réduit au strict minimum chez les espèces de volaille locale en vue de prévenir l'anémie hypotonique hémolytique.

Summary

A total of one hundred and twenty blood samples were obtained from apparently healthy indigenous chickens, guinea fowls, ducks and pigeons for the determination of erythrocyte osmotic fragility (EOF). The EOF was determined in hypotonic saline solutions spectrophotometrically during the harmattan, hot and rainy seasons. The EOF was higher in the chicken and guinea fowl, with minimum and maximum resistance occurring in ranges of 0.65 - 0.75 and 0.25 - 0.35 per cent sodium chloride (%NaCl) concentrations, respectively. It was lower in the pigeon, in which the minimum and maximum resistance occurred in ranges of 0.45 - 0.65 and 0.15 - 0.25% NaCl concentrations, respectively. The derivative fragiligrams of chicken, guinea fowl and duck were unimodal, while that of the pigeon was bimodal. In all the indigenous poultry species, the erythrocytes were more fragile to osmotic lysis during the hot season than the other two seasons. It was concluded that during the hot dry season, hypotonic stress of the erythrocytes should be reduced to the barest minimum in these indigenous poultry species, in order to prevent hypotonic haemolytic anaemia.

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Introduction

The erythrocyte osmotic fragility (EOF) test is related to the geometrical configuration of the erythrocyte. In hypotonic environment, the erythrocyte swells to its maximum; that is, critical haemolytic volume, and becomes spherical before haemolysis. Further increase in cell volume by continuous hypotonic stress will stretch the erythrocyte envelop, and lead to the formation of pores that are large enough to permit leakage of haemoglobin. The EOF test could be used to assess the stability of erythrocytes in hypotonic solutions.

Various authors have reported variations in the EOF of poultry and mammals due to age, species, sex, disease, temperature and types of anticoagulants used. However, there is paucity of information on variations in the northern Guinea Savannah zone of Nigeria. Therefore, the aims of this study were to compare the EOF of four major indigenous poultry species predominately reared under the traditional extensive management system in Zaria and to determine how seasons affect the EOF of these birds.

Materials and methods

Site of experiment

The study was carried out in Zaria (11° 10' N, 07° 38' E) during the three seasons prevailing in the northern Guinea Savannah zone of Nigeria; that is, the harmattan (November to February), hot (March to early June) and rainy (late June to October) seasons of 1998 and 1999.

Meteorological data (Table 1) were collected from the Meteorological Unit, Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria.

Experimental birds

A total of 120 apparently healthy indigenous poultry species, comprising of 30 each of chickens, guinea fowls, ducks and pigeons were used for the experiment. The birds were raised under the traditional extensive management system in Zaria and its environs. They were all about 1-3 years old, except the pigeons which were about six months to one and a half years old.

Laboratory procedures

About 5ml of blood, were collected at random by exsanguination of the birds at local slaughter slabs in Sabon Gari and Samaru markets, Zaria. The blood samples were then kept in a set of Bijou tubes, containing ethylene diamine tetra acetic acid (EDTA). Sodium chloride (NaCl) stock solutions were prepared in volumes of 500ml for each of the test in concentrations, ranging from 0.05 to 0.85%. A set of 10 test tubes were used and each tube contained 10ml of NaCl solution from stock solutions of concentrations. The test tubes were labelled with the corresponding NaCl concentrations, and arranged serially in a test tube rack. One set of the ten test tubes was used to analyse each blood sample. One ml pipette was used to transfer 0.02ml of each blood sample into each of the ten test tubes of a set. Mixing of the test tube contents was performed by gently inverting each test tube five times. All the test tubes were allowed to stand at room temperature (26-28°C) for 30 minutes. The contents of the test tubes were maintained at a pH of 7.4. Thereafter, the contents of the test
tubes were re-mixed and centrifuged at 1,500 revolution per minute for 5 minutes. The supernatant of each was transferred into a glass cuvette. The concentration of haemoglobin solution was measured at a wavelength of 540 nanometre using a spectrophotometer (Spectronic-20, Philip Harris Limited, Shenstone, England) by reading the absorbance.

The same procedure was repeated for each blood sample collected from every poultry species used for the study. The percent (%) haemolysis was calculated according to the equation of Faulkner and King\(^{10}\), as follows:

\[
\text{OD of test} \times 100 = \text{Percent (%) haemolysis}
\]

\[
\text{OD of standard}
\]

where OD = optical density.

OD of distilled water served as the standard.

A cumulative osmotic fragility curve; that is, the fragiligram was obtained by plotting per cent haemolysis of erythrocytes against the saline concentrations.

The derivative fragiligram was then obtained from per cent haemolysis of erythrocyte values by using the principles of "haemolytic increment" of Suess et al.\(^{11}\).

**Statistical analysis**

All data obtained were subjected to statistical analysis using Student’s "t"-test and Chi-square analysis. Data were expressed as mean ±standard error of the mean (mean±SEM). Values of P<0.05 were considered significant.

**Results**

The minimum (10%) and maximum (90%) haemolysis of erythrocytes for the chicken and guinea fowl during the harmattan season occurred in the same % of NaCl concentrations; that is, 0.65 and 0.25%, respectively. During the hot season, the minimum and maximum erythrocyte haemolysis of the chicken and guinea fowl occurred in 0.75 and 0.35% NaCl concentrations, respectively. In the rainy season, maximum erythrocyte haemolysis occurred in 0.25% NaCl concentrations for both species of birds (Table 2).

In the duck and the pigeon, the values of the % NaCl concentration in which
### Table 2: Seasonal and species variation of erythrocyte osmotic fragility of indigenous poultry species in Zaria, % Mean (±SEM).

<table>
<thead>
<tr>
<th>Species</th>
<th>Season</th>
<th>0.85</th>
<th>0.75</th>
<th>0.65</th>
<th>0.55</th>
<th>0.45</th>
<th>0.35</th>
<th>0.25</th>
<th>0.15</th>
<th>0.05</th>
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<td>(±0.02)</td>
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<td></td>
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<td>7.05</td>
<td>7.66</td>
<td>10.00</td>
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<td>40.10</td>
<td>70.90</td>
<td>90.00</td>
<td>100</td>
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<td>91.00</td>
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<tr>
<td>Chicken</td>
<td>Harmattan</td>
<td>(n=10)</td>
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<td>Hot (n=10)</td>
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<td>Guinea fowl</td>
<td>Harmattan</td>
<td>(n=10)</td>
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<tr>
<td>Rainy (n=10)</td>
<td>6.21</td>
<td>6.32</td>
<td>7.10</td>
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<td>39.12</td>
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<td>Duck</td>
<td>Harmattan</td>
<td>(n=10)</td>
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<td>Hot (n=10)</td>
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<td>Rainy (n=10)</td>
<td>8.00</td>
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<td>10.00</td>
<td>19.21</td>
<td>75.20</td>
<td>87.21</td>
<td>90.00</td>
<td>96.50</td>
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<td>97.60</td>
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<tr>
<td>Pigeon</td>
<td>Harmattan</td>
<td>(n=10)</td>
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<td>Hot (n=10)</td>
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<td>Rainy (n=10)</td>
<td>5.20</td>
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<td>7.10</td>
<td>10.00</td>
<td>26.60</td>
<td>67.00</td>
<td>86.00</td>
<td>90.00</td>
<td>97.00</td>
<td>96.50</td>
<td></td>
</tr>
</tbody>
</table>

For each poultry species, no significant difference (χ², P>0.05) in the values between the seasons. 

n = Number of birds.

Minimum and maximum erythrocyte osmotic fragility denote 10 and 90 percent haemolysis of erythrocytes, respectively.

Minimum erythrocyte haemolysis occurred during the harmattan and hot seasons were 0.55 and 0.65, respectively, while that for the pigeon occurred during these two seasons in the duck at 0.25 and 0.35%, respectively while that for the pigeon occurred at 0.15 and 0.25% NaCl concentrations, respectively (Table 2).

Generally, EOF was highest in the indigenous chicken and guinea fowl, and lowest in the pigeon. It was higher during the hot season than either the harmattan or rainy season in all the poultry species, although no significant difference (χ², P>0.05) in values were recorded between the hot season and any of the two seasons (Table 2).

The derivative fragiligrims of the erythrocytes in the chicken, guinea fowl
and duck, each of which has only one peak (Figures 1-3), were termed unimodal, while that for the pigeon which has more than one peak was bimodal (Figure 4).

**Discussion**

The maximum haemolysis of erythrocytes in the chicken and guinea fowls occurred in the same % of NaCl concentrations regardless of the season, but their minimum erythrocyte haemolysis occurred in the same % of NaCl concentrations during the harmattan and hot season. These results suggest that erythrocytes of these two poultry species respond similarly to hypotonic solutions. These findings contradict those of Duotaye and Oyewale, who demonstrated that the erythrocytes of Nigerian domestic

![Graph](image-url)

**Figure 1** Cumulative (A) and derivative (B) erythrocyte osmotic fragility curve of the domestic chicken in Zaria (Mean ± SEM).
Figure 2. Cumulative (A) and derivative (B) erythrocyte osmotic fragility curve of the guinea fowl in Zaria (Mean ± SEM).
chickens are more stable osmotically; that is, they are less fragile, than those of the guinea fowls. However, the minimum and maximum erythrocytes haemolysis obtained in the present study for indigenous chickens were within the ranges obtained for Nigerian domestic chickens in Ibadan, southern Nigeria.

The EOF was higher in the chicken and guinea fowl than in the duck and pigeon. Thus, the erythrocytes of chickens and guinea fowls commenced and completed haemolysis in higher % NaCl concentrations than those for the ducks and pigeons. These results suggest that erythrocytes of indigenous chickens and guinea fowls are more fragile than those of ducks and pigeons and that erythrocytes of pigeons and ducks are more resistant than those of chickens and guinea fowls when placed in the same hypotonic solution.

The variation in the shape of derivative fragiligrams of the pigeon and the other three indigenous poultry species was probably due to differences in ages of the erythrocyte population. This is evidenced by the fact that the derivative fragilogram of the pigeon erythrocytes is bimodal, while those of chickens, guinea fowls and ducks are unimodal. These results support other workers, who demonstrated that unimodal derivative fragilogram is obtained from an erythrocyte population which is homogenous in age; and bimodal fragiligrams are characteristic of heterogenous erythrocyte populations. It, therefore, appears that in the indigenous chicken, guinea fowl and duck, the erythrocytes were predominantly made up of adult cells and the more resistant foetal erythrocytes were almost lacking. However, the bimodal derivative fragiligrams obtained in the pigeon erythrocytes indicate the heterogenous nature of the age of the circulating erythrocytes in the pigeons. Thus, the erythrocyte population of the pigeon apparently consisted of more resistant, foetal erythrocytes. The fact that blood samples were obtained from different age groups in the pigeon supports this finding. Since pigeons are the only birds, whose young ones are considered fit for human consumption by Hausas of northern Nigeria, these birds are usually presented to the markets at an early age for sale and slaughter. It has been shown, that with increase in the age of the erythrocytes, there is a corresponding decrease in the concentration of enzymes involved in metabolism, and consequently, a decrease in the capacity of the cells to degrade oxidants. Also, with increase in age, the lipid layer of the erythrocyte decreases; thus increasing its porosity. The presence of more resistant foetal erythrocytes in young pigeons, could be responsible for the higher resistance of the pigeon erythrocytes in hypotonic solutions than the erythrocytes of any other poultry species used in the present study.

In general, the EOF was highest in the hot season. Therefore, values of the % of NaCl concentrations in which maximum and minimum erythrocyte haemolysis occurred were higher than for those for any other season. The high EOF recorded during the hot season, in which the ambient temperature (AT) was the highest, 30.7°C (Table 1), of all the seasons, could be due to negative effects of heat stress on the erythrocytes, thereby rendering them more fragile and easily susceptible to haemolysis. This finding is in agreement with that of Oyewale who showed that the EOF increases with increase in medium temperature.
FIGURE 3: CUMULATIVE (A) AND DERIVATIVE (B) ERYTHROCYTE OSMOTIC FRAGILITY CURVE OF THE DUCK IN ZARIA (Mean ± SEM).
FIGURE 4. CUMMULATIVE (A) AND DERIVATIVE (B) ERYTHROCYTE OSMOTIC FRAGILITY CURVE OF THE PIGEON IN ZARIA (Mean ± SEM).
In conclusion, of the four indigenous poultry species studied, the pigeon erythrocytes were the most resistant in hypotonic solutions. Also, the erythrocytes of all the four poultry species used in the present study were the most fragile during the hot season prevailing in Zaria.

References


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THE PREVALENCE OF HEARTWATER IN DOMESTIC RUMINANTS IN BOTSWANA

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LA PREVALENCE DE LA COWDRIOSE CHEZ LES RUMINANTS DOMESTIQUES AU BOTSWANA

Résumé

Une étude rétrospective de six ans a été menée afin de déterminer la prévalence de la cowdriose chez les ruminants domestiques au Botswana. Des prélèvements de cerveau de 3,069 ruminants domestiques, y compris 1,038 bovins, 1,602 chèvres et 429 moutons de différents districts, soupçonnés d'être morts de cowdriose, ont été examinés de 1997 à 2002. Le diagnostic de la cowdriose fut confirmé par la détection de l'organisme causal Ehrlichia ruminantium dans les frottis de cerveau. Au total, 1,308 animaux, soit environ 42,62%, étaient diagnostiqués comme étant morts de cowdriose. Les taux de prévalence étaient de 37,57% (390/1,038); 46,12% (739/1,602) et 41,72% (179/429) pour les bovins, les chèvres et les moutons respectivement. Des cas cliniques de la cowdriose étaient enregistrés de tous les districts. Le district de Kanye avait le taux le plus élevé (57,43%; 166/289) de cas de cowdriose provoquant la mortalité chez les animaux, suivi de près par le district de Gaborone avec 53,65% (176/328). Les signes cliniques et les lésions post-mortem observés chez les animaux confirmés comme étant morts de cowdriose étaient notés. La majorité des animaux affectés était soit des animaux exotiques, soit leurs croisements avec la race Tswana. Afin de réduire la mortalité due à la cowdriose, il faudrait entreprendre : l'épidémiologie mettant en relief la propagation des tiques, la campagne de sensibilisation sur les effets néfastes de l'infestation par les tiques, la nécessité de mettre au point un test de diagnostic rapide et d'élaborer des stratégies de lutte contre la cowdriose.

Summary

A six-year retrospective study was conducted to determine the prevalence of heartwater in domestic ruminants in Botswana. Brain samples from 3069 domestic ruminants including 1038 cattle, 1602 goats and 429 sheep from different districts suspected to have died of heartwater were examined from 1997 to 2002. The diagnosis of heartwater was confirmed by detecting the causative Ehrlichia ruminantium organisms in the brain smears. In total, 1308 animals representing about 42.62% were diagnosed as having been died from heartwater. Species-wise prevalence rates were 37.57% (390/1038), 46.12% (739/1602) and 41.72% (179/429) in cattle, goats and sheep, respectively. Clinical cases of heartwater were recorded from all districts. Kanye district contributed the highest percentage 57.43% (166/289) of cases inflicting mortality in animals followed closely by Gaborone district with 53.65% (176/328). Clinical signs and the post-mortem lesions observed in animals confirmed to have died of heartwater were recorded. Majority of the affected animals were either exotic or their crosses with Tswana breeds. The epidemiology highlighting the spread of the vector ticks, awareness campaign on adverse impacts of tick infestation, need to develop a rapid diagnostic test and the control strategies of heartwater should be devised in order to reduce mortality caused by heartwater.

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Introduction

Heartwater is a major tick-borne rickettsiosis of ruminants caused by *Ehrlichia ruminantium*, formerly *Cowdria ruminantium*. It is endemic, often fatal and ranked as one of the major constraints in livestock production in several countries of sub-Saharan Africa. Despite immunization and specific chemotherapy, heartwater remains a major threat to upgrading or replacing the local livestock. Bont ticks of the genus *Amblyomma*, principally *A. hebraeum* and *A. variegatum* are the main vectors of *E. ruminantium* in Botswana. *A. hebraeum* is most commonly found in northeastern, Kgalagadi districts and in eastern parts of Central, Kweneng and Southern districts, whereas *A. variegatum* ticks are restricted to the eastern Chobe region of Botswana. However, recent reports revealed new distribution records of *A. hebraeum* in the sandveld. Unlike in South Africa, where substantial research work has been undertaken on heartwater there is scanty information on the prevalence and economic importance of this disease in Botswana. The need for conducting a tick survey to determine the exact distribution of *Amblyomma* species, active measures to prevent its further spread and the development of cost-effective control strategies were emphasized. According to another report, heartwater cases were confirmed in 803 sheep and goats during the 10-year period from 1984 to 1993 from ranches and private farms rearing upgraded or high graded animals. The present investigation aims to assess the current situation regarding the prevalence of heartwater in cattle, goats and sheep in Botswana over a period of six years from 1997 to 2002. The epidemiology highlighting the spread of the vector ticks throughout the country and the control strategies of heartwater are discussed.

Materials and Methods

Brain samples from 3069 animals comprising 1038 cattle, 429 sheep and 1602 goats with a history of nervous signs, recumbency, sudden death and pathological lesions showing hydrothorax, hydropericardium and congested oedematous lungs were received at the National Veterinary Laboratory (NVL), Gaborone between 1997-2002. The samples included brain tissues, brain crush smears, decapitated heads or carcasses of animals. The symptoms exhibited by the animals and the post-mortem lesions recorded by veterinary field officers in the Disease Reporting Forms accompanying the samples were recorded. Detailed autopsy examination of carcasses and the decapitated heads submitted at NVL was conducted and the crush smears from brain tissues were made. Microscopic examination of the crush smears was carried out in order to detect colonies of *E. ruminantium* in cerebral capillaries after staining them with Giemsa. The proportion of positive/confirmed cases were computed against the total reported cases for all species, then for each specific species and also stratified by districts, months and years. The data were analyzed using standard statistical tools i.e mean, Chi square test for comparison of proportions of positive cases.

Results

The prevalence rates of heartwater from 1997 to 2002 by species, districts and months are presented in Figures 1, 2 and 3. In total, 1308 domestic ruminants were
diagnosed and confirmed as having died from heartwater during the period covered by this study. The highest mean infectivity rate of 46.12% (739/1602) was recorded in goats followed by 41.72% (179/429) in sheep and 37.57% (390/1038) in cattle (Figure 1). No significant differences in the infectivity rates were found between cattle and sheep and between sheep and goats but were significant between cattle and goats (Chi Square 10.36, P<0.01). The percentage of animal mortality was highest and lowest during the years 2000 and 2001 accounting for about 49% and 38%, respectively. Heartwater cases were detected from 17 districts with overall prevalence rates varying from 8.33% to 57.43%. No separate records could be presented in this investigation for two new districts of Hukuntsi and Nata, which were the constituents of Tsabong and Francistown districts till 2002. The most severely affected district was Kanye recording a prevalence rate of 57.43% (166/289) followed closely by Gaborone with 53.65% (176/328). Other details are shown in Figure 2. One case each was reported from Ghanzi and Tsabong for the first time in Botswana. The infection rates for the years 1998 and 2000 differed significantly from that of 2002 (Chi Square 6.44 and 12.31, P<0.01). No significant differences (P>0.05) were demonstrated in the infection rate of 1997 when compared to those of 2001 and 2002.

The cases of heartwater were reported throughout the year in the entire study period. However, the highest mean infection rate of 48.83% was recorded in June followed by 47.74% and 46.37% in May and April, respectively (Figure 3). It was noted that most of the affected animals were either exotic or their crosses with Tswana breeds. Laboratory diagnosis for 106 cases could not be concluded because of the poor quality of brain smears or smears made from the brain tissues with extensive autolytic changes or its preservation either in formalin or boric acid.

The clinical signs observed were fever, dullness, protrusion of tongue, nystagmus, unsteady gait, tremors, occasional circling, falling down and paddling movements. Sudden deaths without showing any clinical signs were frequently recorded also. Dys-
Figure 2: District-wise Distribution of Heartwater in Domestic Ruminants in Botswana During 1997-2002.

Figure 3: Monthly Distribution of Heartwater in Domestic Ruminants in Botswana, 1997-2002.
entry with blood or mucus coated faeces was often noticed in cattle but less so in sheep and goats. The gross post-mortem lesions included hydrothorax, hydropericardium, lung congestion and oedema, ecchymotic or petechial haemorrhages on endocardium, enlarged spleen, hyperaemia and mucosal oedema of abomasum, congested kidneys and intestines. Hydropericardium was usually more pronounced in sheep and goats than cattle and interstitial oedema was more common in cattle.

**Discussion**

In this study, the majority of animals affected were either exotic or their crosses with Tswana breeds. This supports the other reports\(^9,10\) that *Bos indicus* and indigenous breeds of goats and sheep (Persian, Afrikaner) possess a higher degree of natural resistance than *Bos taurus* and exotic breeds of sheep and goats (Merino, Angora) to heartwater. Favourable microclimatic conditions as a result of optimum rains experienced during 1998, 1999 and 2000 thereby enhancing tick multiplication and activities may probably account for the higher prevalence rates of heartwater during these years. Lower infection rates recorded in the years 1997, 2001 and 2002 may possibly be due to prolonged drought conditions affecting adversely the survival and development of *A. hebraeum*, the principal vector tick transmitting *E. ruminantium* microorganisms.

It is amply clear from this investigation that *E. ruminantium* infection has spread to most parts of Botswana. However, the abundance and diversity of vector tick population in the eastern hard veld region\(^2\) may explain for the increased number of clinical cases from Kanye, Gaborone, Lobatse, Mochudi, Mahalapye, Molepolole and Francistown districts. Our observations corresponded with those made in an earlier report\(^6\). In the present study, a comparatively higher number were recorded from the districts of Jwaneng, Letlhakane, Ghanzi, Maun, Kasane, and Shakawe. Scanty case reports from Ghanzi, Tsabong, Shakawe, Kasane, and Maun districts could have been due to submission of fewer samples from these districts or possibly the accidental introduction or a new habitat for vector ticks. The rise in the number of heartwater cases and its gradual spread throughout this country may be as a result of con-
tinuous movements of animals, without dipping and quarantine, from heartwater endemic eastern region over the years. It might have also been influenced considerably by the development of a better road network that has improved the transportation of animals and the vectors to and from these areas.

The present study revealed the constant occurrence of heartwater cases throughout the year. A rising trend in the mean infectivity rate was observed in the month of March peaking highest in the month of June. This coincided well with the onset of winter and towards the middle of autumn seasons in Botswana when adult ticks are found most active. Diagnosis in 106 suspected cases could not be possible because of submission of poor quality brain smears or faulty preservation of brain tissues. Efforts have been made to impart training to the field staff on proper sampling techniques at NVL in collaboration with Center for In-service and Continuous Education (CICE) for last four years.

Clinical signs and pathological lesions observed in the confirmed cases of heartwater were similar to those mentioned in the classical description of the peracute and acute stages of the disease condition. Since these are not pathognomonic difficulties are being experienced in the diagnosis of heartwater in both live and dead animals. At present there is no direct method of demonstrating the causal agents during life except for examination of brain tissue obtained by biopsy in experimental infections which is hardly applicable in a clinical sick animal. Definite diagnosis of heartwater can only be made after death by demonstrating the typical rickettsial inclusions within capillary endothelial cells. Though this method is highly efficient, reliable, rapid and sensitive, yet the diagnosis becomes very difficult and sometimes impossible when the organisms are quite scanty and difficult to find in peracute cases and in animals subjected to treatment 48 hours before wherein the organisms tend to fuse. It would be more appropriate now to develop a rapid test to demonstrate the presence of the causative organisms in the live animals.

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The prevalence of heartwater in domestic ruminants in Botswana.


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SHORT COMMUNICATION

RESPONSE OF Dictyocaulus filaria THIRD STAGE LARVAE TO VARIOUS STIMULI.

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Nematode larvae succumb to various stimuli in different ways. Those responses could be of the flight type to escape or evade the altered environment. For instance, Haemonchus contortus and Trichostrongylus colubriformis coil in receding water films or desiccation\(^1\,^2\). Infective third stage larvae of T. colubriformis were also reported to coil in response to hypertonic solutions\(^3\). The same response was observed from the infective stage of D. filaria\(^4\). The most important energy consuming process of free-living larvae of nematodes is their activity\(^6\). This is specifically very important in free-living larvae of Dictyocaulus filaria as they do not feed in their stay out of the host. Sparing their limited energy is therefore very crucial especially to the infective stages or its vaccine derivatives.

First stage larvae were collected by a modified Baermann technique from faeces of naturally infected lambs. These larvae were suspended in boiled and cooled tap water for 5 days under room temperature to harvest the infective (third stage) larvae.

Third stage larvae were left on slides or in petri-dishes until water was receding or moisture was gone. Larvae were, therefore, observed under those two conditions. The follow-up was made repeatedly to avoid bias and to ascertain uniformity of the larval responses. The effect of darkness on larval responses was studied by placing larvae on a petri-dish over a binocular covered with a larger china mortar that did not transmit light through it. Its effect was studied after removal of conditioning to darkness. In other words such larvae were repeatedly studied with a 15 minute break of darkness and its removal. The effect of increased light as supplied from the microscope was studied after a transient dark lapse situation in an unlit room. Only the general stance of increased activity to the intense light was noted. In order to study the effect of temperature, larvae were kept in the refrigerator (\(4^\circ\)C) for over 6 hours before two examinations. As in other follow-ups, control larvae in water under room temperature were also studied. In order to study the contrasting effects of increased temperature infective larvae were pipetted out on to a slightly warmed slide. Again here only the increased activity was noted. To study the effect of mechanical stimuli, larvae were agitated by gentle shaking or slight vortexing of test tubes containing the larvae. Along with control samples, the differing larval activities were recorded. Fresh infective larvae were suspended in a very high hypertonic solution of Sodium Chloride (NaCl) (0.5M NaCl) to study the effects of hypertonic medium over time.

The infective larval stages of D. filaria were seen to coil in receding water films, desiccation, under low temperature (viz., re-
frigirator temperature (i.e. 4°C), in darkness and under osmotic stress. The type of coiling except to the last stimulus was all flat but it was helical (like a compressed spring) to the osmotic stress in hypertonic solution. These findings are similar to the findings of several authors to other infective larvae of nematodes. For example, Anderson and Levine showed that infective larvae of *Trichostrongylus colubriformis* coiled under desiccation. Todd et al. also reported that third stage larvae of *Haemonchus contortus* coiled in receding water films. Infective stages of *T. colubriformis* were found to coil under hypertonic solutions of even lower concentrations. Both *T. colubriformis* and *H. contortus* infective larvae were found to succumb or coil to osmotic stress within 24 hours (Melaku, Unpublished observations). However, several days elapsed for infective *D. filaria* larvae to show general coiling tendencies in 0.5M NaCl solution. Both the flat and helical coiling of *D. filaria* infective larvae were perfect where the whole length of the larval body is involved.

Coiling of larvae may be an adaptive feature to reduce possible harm from unfavourable conditions. Flat coiling in response to receding water film or desiccation reduces the danger of depleting moisture by reducing exposure of the whole body and grip water within foldings of the coiled larvae. The coiling of infective *D. filaria* infective larvae to darkness is probably a synchronized response to low temperatures of dark hours but perhaps also as an adaptive feature to the dark hours of the day when larvae need not move up the blade of the grass in such hours.

Coiling of the infective larvae of *D. filaria*, which was helical may decrease the outward body pressure of the larval hydroskeleton upon coiling necessitating little or no energy to maintain the coiling. It may also reduce the porosity of the larval body cuticle. These findings indicate that larvae can conserve energy under such stimuli as reduced temperature, darkness, osmotic stress and through careful handling where the larvae or their vaccines are not agitated. The most important energy consuming process of free-living larvae is their activity. Use of these findings may improve the shelf life of the larvae or their vaccines. Prevention or control measures of the parasite may be possible through vaccination.

**Acknowledgements**

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**References**


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SHORT COMMUNICATION

EVALUATION OF THE EFFICACY OF ALZOLE AND TETRACLOZAM FOR THE TREATMENT OF BOVINE TREMATODIASES IN CHAFFA ROBIT DISTRICT, NORTHEASTERN, ETHIOPIA

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Bovine trematodiases are widespread and cause morbidity and mortality in cattle in endemic countries¹. Fascioliasis is one of them and commonly occurs as a chronic disease in cattle. Its severity also depends on the nutritional status of the host. In Ethiopia, numerous coprological and slaughterhouse studies have shown a high occurrence and widespread distribution of fascioliasis in ruminants²³. The disease is caused by Fasciola hepatica and Fasciola gigantica, which are transmitted by Lymnaea truncatula and Lymnaea natalensis, respectively⁴. Bovine schistosomiasis caused by Schistosoma bovis also occurs in Ethiopia. The few studies conducted on bovine schistosomiasis in Ethiopia indicate prevalence rates ranging from 28-33.8%⁵⁶. Similarly, studies have indicated the occurrence of bovine paramphistomiasis in Ethiopia⁴⁷.

The present study was, therefore, undertaken to determine the efficacies of Alzole and Tetraclozam for treatment of bovine trematodiases in Chaffa Robit District, northeastern Ethiopia.

Chaffa Robit District is located 300 km northeast of Addis Ababa. Two villages, Cherety and Dimtu, were selected because of their proximity to marshy grazing areas. Chaffa Robit is one of the districts with the largest cattle population in the area. The snails found in the marshes include Bulinus truncatus and Bulinus forskali.

A total of 163 heads of cattle belonging to 10 herds were included in this study. Four herds were from Cherety while six herds were from Dimtu. During data collection, such details as name, age, sex and body condition of individual animals were recorded.

Fresh fecal samples were collected from the recta of the study animals and placed in plastic vials and preserved in 3% formalin. The specimens were examined using a sedimentation technique⁸.

Two anthelmintics namely, Alzole® 2500 (East African Pharmaceuticals Pvt. Ltd. Co.) and Tetraclozam® (DHEMAN, new Pharm, Beker), were administered to animals found excreting trematode eggs in single doses of 10mg/kg and 16mg/kg body weight, respectively. Alzole® was used at Dimtu while Tetraclozam® was used at Cherety.

Cure rate was expressed as percentage for each drug whereas chi-square (χ²) test and Fisher’s exact⁹ were used for the
analysis of the results with P<0.05 as statistically significant.

The prevalence of infection by three trematodes in the study animals is presented in Table 1. A highly significant difference was observed in the prevalence of fascioliasis, paramphistomiasis and schistosomiasis among the study animals (χ²=57.84; P=0.001). However, the difference in the proportion of fascioliasis and paramphistomiasis was not statistically significant (χ²=2.69; P=0.101). In addition, schistosomiasis was more prevalent than fascioliasis and paramphistomiasis in the study animals (P<0.001). Schistosomiasis was found to be the most prevalent trematode infection in both villages while fascioliasis was relatively the least prevalent one.

The cure rates of Alzole® and Tetraclozam in the three trematodiases are presented in Table 2. Tetraclozam® was found to have higher cure rate (66.67%) against fascioliasis than Alzole® (cure rate = 42.86%). Alzole® did not have any effect (cure rate = nil) against paramphistomiasis while Tetraclozam® was highly effective (cure rate = 92.86%).

The present study showed that schistosomiasis, paramphistomiasis and fascioliasis are widespread in Chaffa Robit District, northeastern Ethiopia. The prevalence of infection reported in this paper for Schistosoma bovis is higher that that reported from other parts of the country. Those earlier studies reported prevalences ranging from 28% to 33% for schistosomiasis.

In Ethiopia, Fasciola hepatica is widely distributed in areas with altitude above 1800m while Fasciola gigantica appears to be the most common species in places with altitude below 1200m. On the other hand, information available on paramphistomiasis and schistosomiasis in the country is scanty.

Climatic conditions of Chaffa Robit are highly conducive for the breeding of snails. Thus, the occurrence of snails has been reported in direct relation to the pervasiveness of these parasitic infections.

The results of the efficacy tests of the two drugs indicated that Tetraclozam® has a better effect on both Fasciola spp. and Paramphistomum spp. than Alzole®. Conversely, Tetraclozam® did not have any effect on Schistosoma bovis. All of the animals that were excreting Schistosoma bovis eggs before treatment were found to excrete eggs three weeks post treatment. Furthermore, though widely used in veterinary clinics all over Ethiopia, Alzole® was found to have less effect on bovine trematodes, particularly on Fasciola spp. and Schistosoma bovis. As observed from the results

<table>
<thead>
<tr>
<th>Village</th>
<th>No. of cattle examined</th>
<th>Trematode species</th>
<th>No. positive (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cherety</td>
<td>81</td>
<td>Fasciola spp.</td>
<td>15 (18.52%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Paramphistomum spp.</td>
<td>28 (34.57%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Schistosoma bovis</td>
<td>33 (40.74%)</td>
</tr>
<tr>
<td>Dimtu</td>
<td>82</td>
<td>Fasciola spp.</td>
<td>21 (25.65%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Paramphistomum spp.</td>
<td>21 (25.61%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Schistosoma bovis</td>
<td>66 (80.49%)</td>
</tr>
<tr>
<td>Total</td>
<td>163</td>
<td>Fasciola spp.</td>
<td>36 (22.10%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Paramphistomum spp.</td>
<td>49 (30.10%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Schistosoma bovis</td>
<td>99 (60.74%)</td>
</tr>
</tbody>
</table>
Table 2: The cure rate of Alzole and Tetraclozam on bovine trematodiases in Chaffa Robit District, Northeastern Ethiopia

<table>
<thead>
<tr>
<th>Trematode species</th>
<th>Drugs</th>
<th>No. cattle examined</th>
<th>No. excreting eggs</th>
<th>Cure rate (%)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Before treatment</td>
<td>After treatment</td>
<td></td>
</tr>
<tr>
<td>F. spp.</td>
<td>Alzole</td>
<td>82</td>
<td>21</td>
<td>12</td>
<td>42.86%</td>
</tr>
<tr>
<td></td>
<td>Tetraclozam</td>
<td>81</td>
<td>15</td>
<td>5</td>
<td>66.67%</td>
</tr>
<tr>
<td>Paramphistomum spp.</td>
<td>Alzole</td>
<td>82</td>
<td>21</td>
<td>21</td>
<td>Nil</td>
</tr>
<tr>
<td></td>
<td>Tetraclozam</td>
<td>81</td>
<td>28</td>
<td>2</td>
<td>92.86%</td>
</tr>
<tr>
<td>Schistosoma bovis</td>
<td>Alzole</td>
<td>82</td>
<td>66</td>
<td>39</td>
<td>40.91%</td>
</tr>
<tr>
<td></td>
<td>Tetraclozam</td>
<td>81</td>
<td>33</td>
<td>33</td>
<td>Nil</td>
</tr>
</tbody>
</table>

of the present study, neither Alzole® nor Tetraclozam® demonstrated any effect on the most prevalent Schistosoma bovis in the study animals. Further investigations are recommended on the efficacies of available drugs to determine effective doses or a multi-spectrum trematocide.

Acknowledgements

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SHORT COMMUNICATION

PREVALENCE OF GASTROINTESTINAL PARASITES OF PIGS IN KADUNA, NIGERIA

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Gastrointestinal helminthiasis is by far the commonest and most important disease of pigs in the tropics¹². Generally, helminth infestations in pigs is fundamentally said to be a herd problem, the acquisition of which depends greatly on the availability of extra host stages of the parasites as well as the prevailing husbandry practices. A wide range of helminth infestations have been documented in pigs in Nigeria³⁴. Although most of such reported helminths of pigs have no known public health significance, their presence in swines is associated with severe economic losses as evidenced by poor growth rate, reduced weight gains and visceral organ condemnations during meat inspection.

Gastrointestinal helminthiasis is generally said to be a problem of the young in all animal species, including humans⁵. This is attributed to the development of active immunity in the adult animals following repeated exposures to helminth parasites⁶.

In Nigeria, the slaughter and consumption of piglets is an unusual practice amongst the population that consumes pork and pork products. Only adult pigs of slaughter weight (about 70 kg) are usually presented for slaughter. Because such animals are of the local breeds, that have a slow growth rate and attain the 70 kg body weight at over one year of age. The objective of the present study was to determine the prevalence of common gastrointestinal parasites encountered in adult pigs slaughtered within Kaduna Metropolis, Nigeria.

Fecal samples from 200 adult pigs slaughtered at Kaduna slaughter slab were examined for gastrointestinal parasites using egg floatation technique (EFT) as described earlier⁷. The fecal samples were collected in small sample bottles soon after each pig was slaughtered. Those to be examined on the later dates were preserved in 10% formal saline solution to prevent the eggs from undergoing degenerative changes. Formal saline (10%) was prepared as described previously⁸.

Of the 200 fecal samples examined for the presence of gastrointestinal parasites, 69% (138) were found to be positive for gastrointestinal parasites as shown in Figure 1. Out of this, 11% (22), 2% (4), 3.5% (7), 0.5% (1), 48.5% (97), 1% (2), 2% (4) and 0.5% (1) were Ascaris suum, Coccidia oocysts, Entamoeba spp and unidentified parasites respectively. These were only

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pure infections i.e. no mixed infections were observed in this study.

The prevalence of GIT parasites encountered in this study is relatively high when compared to similar studies conducted in Nigeria\(^4\). The pigs offered for slaughter at the Kaduna slaughter slab were reared in the villages outside the Metropolis of Kaduna under extensive management, with little or no veterinary attention. Under such management, pigs are exposed to continuous infestation and re-infestation with GIT parasites. There was no information as to whether any of the pigs slaughtered had previous treatment against parasitic infestations.

Unlike young pigs, the most commonly encountered helminth in adult pigs at slaughter in this study was hookworm species (48.5%). *Ascaris suum* which is most commonly seen in young pigs\(^4\) accounted for 11% of total parasites detected. Previous works have been conducted on gastrointestinal parasitism in pigs in Nigeria\(^4,10,11\), but this is the first survey work on GIT parasites of adult pigs in Kaduna Metropolis. Kaduna town is located in North-Western Nigeria, where pig population is very high. Although none of helminths encountered in this study is of any public health importance, serious economic consequences may result in the animals, especially if such animals are to be maintained on the farms for longer periods as the case of breeding herds.

From the result of this work, it was predicted that one of the major causes of death of pigs in Kaduna may be GIT parasitism. It was recommended that extensive management of rearing pigs

![Figure 1: Gastrointestinal parasites of adult pigs slaughtered in Kaduna, Nigeria](image-url)
should be discouraged among local farmers, a definite health program encompassing the control of GIT parasites should be designed and good sanitary measures should be put in place to control GIT parasitism in this species. Pigs reared in Kaduna and its surrounding villages/suburbs should therefore, be kept under intensive management with good veterinary attention. It is suggested that more work should be conducted on this subject in Kaduna Metropolis, as this is the first work of its kind on adult pigs in this part of Nigeria.

Acknowledgement

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References


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SHORT COMMUNICATION

CONTROL OF HELMINTH PARASITES OF DOGS IN DSCHANG, CAMEROON USING STROMITEN®

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²University of Dschang, Faculty of Agronomy and Agricultural Sciences, B.P 222, Dschang, Cameroon

Irresponsible ownerships of dogs have become increasing concerns for both veterinary and medical professionals including their impact on environmental pollution¹. They harbour intestinal parasites, which are of public health importance²,³. Although our concern must necessarily be with the health and performance of the animal, the threat to public health from zoonotic endoparasitic infection is worthy of consideration. The larva migrans syndrome caused by migration of juvenile ascarids and/or hookworms occur in humans and are most prevalent among those living in severely contaminated areas.

The epidemiology and level of control of endoparasites, in many parts of the world including tropical areas, with anthelmintic agents have been determined and documented⁴,⁵. Though various levels of anthelmintic drug resistance have been proposed in different species of animals, there is only scanty information on the state and level of control of dog endoparasitism in Cameroon. Stromiten® which is a broad-spectrum anthelmintic agent has very high efficacy against dog endoparasites especially nematodes and cestodes in many places⁶,⁷ but the level of usage and anthelmintic effectiveness of this drug in Cameroon is not known.

A total of 35 dogs infested with gastrointestinal parasites and randomly selected from amongst naturally infested dogs during a parasitic survey conducted in Dschang area were used in this work. The dogs were 3 months to 7 years old, weighing 4.0 to 30 kg and included 21 males and 14 females. The natural infestation was established by faecal flotation and McMaster egg count methods. Helminth ova observed were identified as described before⁸. Nematodes (hookworm, T. canis, T. vulpis, S. stercoralis, and C. aerophila) and cestode segments (D. caninum and Taenia spp) were recovered from the dog faeces in this work with high incidence and intensity values recorded for T. canis and the various hookworm species.

Infected animals were then treated with Stromiten® administered at a rate of one tablet per 5 kg body weight (1tab/5kg bwt). The drug used was purchased from the local market. Treatment was done within 1 to 3 days following the determination of gastrointestinal parasitic infestation. For

*Corresponding Author
### Table 1: Anthelmintic efficacy of stromiten® in dogs from Dschang Cameroon.

<table>
<thead>
<tr>
<th>PARASITE</th>
<th>BEFORE TREATMENT</th>
<th></th>
<th>4 DAYS AFTER TREATMENT</th>
<th></th>
<th>CRITICAL EFFICACY (E%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prevalence</td>
<td>Egg count</td>
<td>Prevalence</td>
<td>Egg count</td>
<td></td>
</tr>
<tr>
<td>Hookworms</td>
<td>85.71 (n=30)</td>
<td>1323 ± 1522</td>
<td>11.43 (n=4)</td>
<td>12 ± 31</td>
<td>99.10</td>
</tr>
<tr>
<td>Toxocara canis</td>
<td>45.71 (n=16)</td>
<td>16175 ± 21492</td>
<td>22.86 (n=8)</td>
<td>63 ± 94</td>
<td>99.61</td>
</tr>
<tr>
<td>Trichuris vulpis</td>
<td>8.57 (n=3)</td>
<td>100 ± 87</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Strongyloides stercoralis</td>
<td>5.71 (n=2)</td>
<td>825 ± 460</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Capillaria aerophila</td>
<td>2.86 (n=1)</td>
<td>300 ± 0</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Dipylidium caninum</td>
<td>8.57 (n=3)</td>
<td>00*</td>
<td>0</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>Taenia segments</td>
<td>5.71 (n=2)</td>
<td>00*</td>
<td>0</td>
<td>-</td>
<td>100</td>
</tr>
</tbody>
</table>

n = Number of dogs infested  
* Segments seen before treatment

Puppies and easily restrained dogs, the drug was placed at the back of the mouth, water poured in and the mouth closed while stroking the throat externally with fingers until the drug/water mixture was swallowed. For dogs that were bigger and difficult to restrain, the tablets were ground and mixed with a small quantity of their food or meat at mealtime. The rest of the meal and water were then given after dosing. The animals were observed for 14 days for abnormalities (side effects such as vomiting, diarrhoea, loss of appetite and restlessness).

Four and fourteen days post treatment, faecal samples were collected for examination and identification of helminths as before treatment.

With each animal serving as its own control, the critical efficacy (E) for each parasite species following treatment was calculated using the following formula described by Sharp and McCurdy:

\[ E = \left( \frac{OP}{OP + OR} \right) \times 100 \]

E = Critical efficacy,  
OP = Number of parasite ova passed (before treatment);  
OR = Number of parasite ova retained (after treatment).

Table 1 summarizes the dog helminth ova passed before Stromiten® treatment, those retained after treatment and the critical anthelmintic efficacy of the drug in dogs in Dschang area.

Four days after treatment of the infested dogs, over 99% reduction of hookworm and Toxocara canis ova were achieved while there was complete elimination of S. stercoralis, T. vulpis and C. aerophila ova. Tapeworm segments also disappeared completely from the faeces of infected dogs. Furthermore, no helminth developmental stage was observed in faecal samples fourteen days after treatment and the animals showed neither signs of vomiting, diarrhoea, loss of appetite nor restlessness.

The broad-spectrum anthelmintic efficacy of Stromiten® against dog helminths recorded in this study agrees strongly with earlier reports. The efficacy values achieved for levamisole in the combination...
product against the nematode species (hookworm and *T. canis*) are similar to those recorded by earlier\(^1\). The present data also confirms the cestoidal activity of niclosamide as there was complete elimination of *D. caninum* and *Taenia* spp. from infested dogs four days post treatment.

This work therefore confirms the high individual anthelmintic activities of levamisole and niclosamide in their combination therapy of dogs in Dschang area with Stromiten\(^8\) and recommends its use to control the high dog endoparasitic infection and intensity rates in the region. However, more work on the epidemiology and control of dog parasites in Cameroon is also recommended with particular attention towards drug resistance and zoonotic or public health importance.

References


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SHORT COMMUNICATION

CROWING BY UNDER-AGED COCKEREL IN A BROILER FLOCK

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The act of crowing in male domestic chicken is a sex-associated trait and its onset is pointer to the attainment of puberty, which in itself is age dependent. However, the level of nutrition, environment and general management may influence the onset of puberty. The male hormone testosterone appears to be the main physiological agent influencing attainment of puberty. This hormone also has a concomitant effect on the comb and wattles development. Under its influence, these structures become more developed and reddish at puberty.

There is hardly a report in the literature of crowing taking place in a cockerel before the age of puberty. This report therefore may be an isolated observation of crowing at an early age of 6 weeks.

The observation was in a flock of home grown straight-run broiler chickens consisting of about 15 birds. The birds were reared conventionally on litter and fed commercial broiler chicken diets consisting of a starter mash to 5 weeks of age and a finisher mash thereafter. These diets contained 23% crude protein with 3060 kcal of metabolizable energy per kilogram, and 20% crude protein with 3100 kcal of metabolizable energy per kilogram respectively. However, one of the cockerels appeared to exhibit faster growth than the others and also showed better comb and wattles development. At about 6 weeks of age, this faster growing cockerel was observed to be making early crowing attempts.

This bird was appropriately identified for further observation. Two non-crowing male counterparts of this cockerel were picked randomly and sacrificed along with the crowing cockerel at 7 weeks of age, for detailed study, which included examining their combs, wattles and testicular

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Crowing cockerel</th>
<th>Non-crowing cockerel (mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weight (kg)</td>
<td>2.2kg</td>
<td>1.72kg</td>
</tr>
<tr>
<td>Comb size (g)</td>
<td>2.97 g</td>
<td>0.96 kg</td>
</tr>
<tr>
<td>Wattle size (g)</td>
<td>0.97 g</td>
<td>0.47 g</td>
</tr>
<tr>
<td>Testes size (g)</td>
<td>0.22g</td>
<td>0.22 g</td>
</tr>
</tbody>
</table>

Table 1: Comb, wattles and testes size(s) of the crowing and non-crowing broiler chickens at 7 weeks of age (when the birds were sacrificed).
development. Before slaughter, the three birds were weighed. The data obtained are presented in Table 1.

Crowing comes with puberty and improves with sexual maturity. It is therefore initiated at the hormonal level and testosterone.

Crowing is a secondary sex characteristic of the male. It has been reported that the secondary sexual characteristics of the male are highly dependent upon the androgen hormone and that such characters include the comb and wattle of roosters. In the present observation, because proper comb and wattle development appeared to coincide with the onset of crowing, it is suggested therefore that their occurrence was initiated by the same hormonal action, probably testosterone activity, perhaps in synergism with other hormones.

The crowing cockerel in the present observation, had a higher comb size than the mean of the two non-crowing cockerel. This was also true of wattles and testicle sizes. Although hormone assay that would have aided the determination of the hormones at play was not conducted, it would appear that the higher weight differentials in the crowing cockerel weights in respect of these parameters, resulted from more intense hormonal activities in its organs than there were, in its non-crowing counterparts.

Earlier workers have reported that growth and development are a function of many hormones and it is possible to establish a definite role for each and every hormone. It would appear that the more rapid testicular development in the crowing cockerel resulted in early production of testosterone which is the hormone causing the development of secondary sex characters. Testosterone is also reported to influence the development of the larynx, which is an important organ of vocalization. This may have accounted for the well-defined voice production and ability to crow at that early age.

Whatever factors(s) stimulated the rapid testicular development and production of testosterone and or other hormones in the cockerel at that early age remains a matter of speculation.

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


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

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- des brèves communications.
- analyse des articles proposés par le Rédacteur.
- des éditoriaux.
- le courrier des lecteurs.
- analyse d'ouvrages.
- informations et annonces.

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

L'introduction expose le but de la recherche.
Le matériel et les méthodes utilisés.
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