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Whenever possible articles should take the following structure: (1) title (2) name(s) and address(es) of the authors(s) (3) Summary (4) Introduction (5) Material(s) and Method(s) (6) Results (7) Discussion (8) Acknowledgement (9) References

Papers should be typewritten on one side of the paper only in English or French. Double line spacing and adequate margins are desirable. The original and one carbon copy are required.

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Papers should contain a summary, which should be factual, should convey the contents of the paper and should draw attention to new information and the the main conclusions.

Headings and sub-heads should not be underlined. Binomial specific names and other words to be printed in italics should have a dotted underline.

Tables should be limited and be typed on separate sheets of paper numbered consecutively, Table 1, Table 2, etc. Figures, including photographic prints, graphs, maps, etc. should be numbered consecutively, Fig. 1, Fig. 2, etc. and attached at the end of the text. References to tables and figures in the text should be by number and not to "table below" or "figure below". Coloured illustrations are reproduced only at the author's expense.

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References should include, in the following order, surname, initials of author(s), year of publication (in parentheses), World List abbreviation of title of periodical (dotted underline), volume number (arabic numerals underlined), first page number. The title of the article should not be included.

References to books should include name and initials of author(s), year of publication (in parentheses), the exact title (underlined), town of publication, page number (if page number specifically cited). If

References to annual reports should state the country, year of references, followed by the name of the department or organisation, e.g. Kenya (1955) An. Rep. Dept. Vet. Services, p. 50 (if specific page cited).

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Abstracts No. 85-110.
SURVEY OF THE MANAGEMENT AND PRODUCTIVITY OF INDIGENOUS CATTLE IN ZAMBIA

R. NADARAJA, A. CHIMWANO, B. MWANAIMO and A. MEhra
University of Zambia, School of Agricultural Sciences, Box 32379, Lusaka, Zambia.

SUMMARY

A total of 1407 indigenous beef cattle under traditional management were studied over a four year period from 1975 to 1978. The cattle were distributed among 32 herd owners whose management practices were about similar. The study focused on management practices, seasonal body weight changes, incidence of disease, reproductive abnormalities, bull/cow ratio, off-take and calving rates. In all cases, cattle were herded throughout the year by either owners or hired labour. There was a 30% incidence of transhumance during periods of poor grazing and low water availability. There was no significant (P>0.05) seasonal variation in body weight changes in male animals. Female animals recorded significant (P<0.05) weight gains during the rainy months of December to April, and a highly significant (P<0.01) loss in body weight during the cool dry months of May to August.

Although the incidence of brucellosis in the herd was low, at 4.8%, the more common diseases were those transmitted by ticks and worm infestations, with Senkobo (Cutaneous Streptothricosis), Hemorrhagic Septicaemia and deaths due to predators contributing equally to herd losses and low productivity.

There was a low level of cystic and hypoplastic ovaries in females while the semen from bulls did not show any abnormalities. The bull/cow ratio ranged from 1:21 to 1:64 with a total herd average of 1:45. The average annual herd off-take was 6.2%. The average calving rate for the four years was 27.9%. The productivity index of the indigenous cow was estimated at 19.1 kg per 100 kg maintained per annum.

INTRODUCTION

Out of a total beef cattle population of two million in Zambia, 80% are of the indigenous Sanga and Zebu breeds and are kept in the traditional sector (Perry et al., 1982; Bessel and Daplyn, 1977; Mason and Maule, 1960). Although the roles of traditionally owned cattle in Africa have been variously elaborated (Trail, 1979; Matthewman, 1980; Fielder, 1983), their general productivity and off-take is considerably low (Van Raay, 1975; Matthewman, 1980). Among the several factors which have been advanced for this low level of productivity in the traditional sector are poor levels of management and nutrition (Johnston et al., 1971; Oguntowora et al., 1975). On the other hand, Trail (1979), citing the Botswana experience has advocated for the preservation and improvement of indigenous breeds of cattle.

The objective of this study was to determine the management practices and the factors which affect the productivity of indigenous cattle in the Mukulaikwa area of Zambia.

MATERIALS AND METHODS

The study was conducted in the Mukulaikwa area 50 kilometres West of Lusaka. The area is typical Savannah, receiving an annual rainfall of 900-1000mm which falls between mid-November and mid-April. The grass vegetation is predominantly of Hyparrhenia/

Heteropogon spp. combination which grows rapidly with on-set of the rains. However the natural grazing soon becomes fibrous and for the remainder of the year is typically "standing" hay of low nutritional value (Van Rensburg, 1968). The sample studied consisted of 1270 heads of indigenous cattle over one year of age and 137 calves under one year of age. The animals were distributed among 32 herd owners. The sample included 491 breeding cows, 307 male castrates used for draught purposes (oxen), 243 male castrates between 1-3.5 years old (steers), 215 females between 1-3.5 years old (heifers) and 14 breeding bulls. The age of animals was determined from their dentition (Sisson and Grossman, 1953).

The management factors which were studied included calf rearing, cattle herding, breeding practices, Veterinary practices, the herd structures and cattle ownership. Body weight changes of ear-tagged breeding cows, bulls and oxen were recorded monthly using standard cattle weighbridges. During each monthly weighing, all animals were hand sprayed against ticks and given Veterinary attention. All other management practices were as per individual owner's routine.

Reproductive disorders in breeding females were determined on each cow once a year by rectal palpation focussing on the ovaries. Semen in the breeding males was collected by electro-ejaculation (Mattner and Voglmayr, 1962) and
examined for mortality and morbidities. Throughout the four years, monthly calving rates per herd were recorded on all breeding females. Diagnosis of disease was done by a veterinarian while the herd structures, herding methods, calf rearing systems, off-takes and cattle ownership were determined once a year by a questionnaire.

The seasonal body weight data were analysed according to Steel and Torrie (1981). The productivity index of 100 kg cow maintained per annum was derived from the method used by ILCA (1979), using the average milk yield data of Bessel and Daplyn (1977).

RESULTS AND DISCUSSION

Management and Herd Structures

Cattle were herded throughout the year due to intensive cropping which occurs in the study area. In 90% of the cases, cattle owners herded the cattle, only 10% were herded by hired labour. In general, cattle left for grazing at 08.00 hours and returned from kraaling at 17.00 hours each day. During the five rainy season months, cattle were strictly herded on communal grasslands, usually five kilometres from the homestead while during the post-crop harvest months of June and July, cattle were grazed on crop residues in the fields. Similar findings have been made (ILCA, 1979) among sedentary cattle rearers in West Africa. About 30% of the herds migrated from end of July to end of October with their herders 40 kilometres to the river flood plains, where grass is generally abundant and of high nutritive value (Verboom and Brant, 1970). This system of semi-transhumance has been reported with varying degrees of intensity in other parts of Africa (Johnson, 1969). Night penning of untethered cattle is done in kraals located some 100 metres from the homestead, usually on high ground to reduce mud accumulation during rains.

Although calves are born throughout the year, about 70% of calving occurred between the months of June and October, with the peak in October (Figure 3). Milking for human consumption usually started during the second week post-calving and was done once a day early in the morning. During two weeks after calving, calves were herded near the homestead with their dams, as is practiced in most parts of Zambia (Hanalete, 1980; Bessel and Daplyn, 1977). This observation is in contrast to ILCA’s (1979) finding in West African sedentary herders who practice milking twice a day. In 84% of the herds, calves below the age of six months were herded and penned separately, they were brought to their dams for two hours before penning and during milking. In the remaining 16% of herds, calves were herded and penned with their dams.

In 70% of the herds, male calves were castrated by the Government veterinary staff while 30% of the herd owners did their own castrations, in all cases using the burdizzo. Only about 9% of herd owners received regular veterinary assistance. Throughout the year, only 15% of the herds were never dipped against ticks. The average calf mortality to age of one year was 15% against a national average of 20%, the cow mortality of 8% was within the national average (Perry et al., 1982). About 60% of calf mortality occurred between December and February. Cow mortality however did not show specific peaks and was due to a multiplicity of causes such as Hemorrhagic Septicaemia and Senkobo (Cutaneous Streptothricosis) complications.

The herd structures bull/cow ratios and the calving rates during each of the four years are shown in Table 1. The mean herd structures are further illustrated in Figure 1 while the monthly calving rates are presented in Figure 3.

The herd structure remained fairly uniform except for the breeding cows which rose by 5.8% by the fourth year. This represents normal entry of heifers into the breeding herd which is normally after 3.5 years, as well as retention by owners of old cows in excess of nine years and preference to sell mainly male castrates of over 3.5 years old. The herd structure, except for calves, is in general agreement with those observed elsewhere in Zambia (Allen, 1966; Perry et al., 1982) as well as in other parts of Africa (Van Raay, 1975; ILCA,
Table 1: Herd structures and bull/cow ratios throughout the study period (1975-1978)*

(Percent basis)

<table>
<thead>
<tr>
<th></th>
<th>1975</th>
<th>1976</th>
<th>1977</th>
<th>1978</th>
<th>X</th>
<th>±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breeding cows</td>
<td>32.0</td>
<td>34.5</td>
<td>35.3</td>
<td>38.2</td>
<td>34.9</td>
<td>± 3.4</td>
</tr>
<tr>
<td>Bulls</td>
<td>0.5</td>
<td>0.7</td>
<td>0.8</td>
<td>1.8</td>
<td>1.0</td>
<td>± 0.9</td>
</tr>
<tr>
<td>Oxen</td>
<td>25.0</td>
<td>21.2</td>
<td>21.2</td>
<td>19.8</td>
<td>21.9</td>
<td>± 1.9</td>
</tr>
<tr>
<td>Steers</td>
<td>24.6</td>
<td>18.0</td>
<td>14.0</td>
<td>13.0</td>
<td>17.4</td>
<td>± 4.9</td>
</tr>
<tr>
<td>Heifers</td>
<td>13.0</td>
<td>16.0</td>
<td>15.7</td>
<td>15.8</td>
<td>15.1</td>
<td>± 1.5</td>
</tr>
<tr>
<td>Calves</td>
<td>4.9</td>
<td>9.6</td>
<td>13.0</td>
<td>11.4</td>
<td>9.7</td>
<td>± 3.1</td>
</tr>
<tr>
<td>Bull: Cow ratio</td>
<td>1:64</td>
<td>1:49</td>
<td>1:44</td>
<td>1:21</td>
<td>1:45</td>
<td>± 13.9</td>
</tr>
</tbody>
</table>

* Based on 1407 heads of cattle in 32 herds

1979). There was however a great deficit of bulls, the bull to cow ratios ranged from 1:21 to 1:64 with an average of 1:45 against a national average of 1:26 (Perry et al., 1982). It was common for one bull to serve in as many as five different herds. The incidence of reproductive diseases was low. The occurrence of brucellosis was found to be 4.8%. This is very low compared to the incidence of the disease in other parts of Zambia (Nadaraja, 1978). The deficit of bulls appears to be a major contributor to the average low calving rate of 28% observed in this study against a national average of 61% (Perry et al., 1982). This is despite the fact that there was no specific breeding season as cows and bulls were run together throughout the year, the calving interval was found to be in excess of two years, which is higher than the 18 months reported in Malawian cows (Koning, 1977). The number of oxen retained clearly demonstrates the intensive use of these animals for traction. However, this situation still contrasts to that which attains in the Gambia where up to 40% of the total herd consists of oxen which are normally loaned to other farmers for traction (USAID, 1977).

The annual cattle off-take was 6.2%, and 68% of cattle sales took place during the dry season months of June to October due largely to lack of quality grazing. Although in any year 68% of herd owner sold varying numbers of animals, 1.2% of annual off-take was cattle slaughtered for household consumption during festivities. The National off-take in the traditional sector is estimated at 10% of which 2.5% is due to slaughter for home consumption, 4.5% sold and 3% being transfers, especially as dowry payment (Perry et al., 1982). The cattle sold predominantly consisted of steers, culled cows and oxen.

Seasonal Body Weight Changes

The results of the average seasonal weight changes for both breeding cows and oxen are shown in Fig. 3, while mean monthly weight changes are presented in Table 2. Three specific periods have been chosen to correspond with broad changes in the climatic regime and grazing availability namely December to April (rainy season), May to August (cold dry season) and September to November (the hot season). On the average, oxen did not exhibit significant (P > 0.05) variation in body weight during the seasons. On the other hand, marked variations were observed in body weights of breeding females. The females recorded a significant (P < 0.05) gain in weight between December-April, this being a period of abundant highly nutritious grazing with average crude protein levels of 10% in the dry matter (Smith and Hodnett, 1962). They exhibited a highly significant weight (P < 0.01) loss during May to August largely due to the very poor nutritional level of the natural grazing, with protein content as low as 2.0% in the dry matter (Chimwano, 1980). There was no significant weight loss during September to November. The differences in seasonal body weight changes between
Oxen and cows are largely due to the fact that the females are either in-calf or suckling during much of the year.

The productivity index per 100 kg cow maintained per annum was found to be 19.1 kg, which is lower than the range of 20.2% to 26.5 kg found by ILCA (1979) in indigenous cattle breeds of West Africa.
Fig. 2: LIVESTOCK BODY CHANGES DURING VARIOUS SEASONS

Fig. 3: CALVING RATES DURING VARIOUS SEASONS
ACKNOWLEDGEMENTS

The authors are grateful to the University of Zambia Research Grants Committee and the Ministry of Agriculture for financial support. Dr. S. Ochitom offered valuable suggestions during the preparation of the publication.

REFERENCES


Received for publication on 23rd November, 1982.
PRELIMINARY STUDIES ON THE EFFECT OF FEEDING CUCUMIS DIPSACEUS TO SHEEP & GOATS

SALAH HASSAN IDRIS, A/GADIR A. WAHBI and OMER F. IDRIS
Veterinary Research Administration, P.O. Box 8067, Elamarat, Khartoum, Sudan.

SUMMARY

A preliminary study on C. dipsaceus fruit confirmed its toxicity to sheep and goats. The fruits were toxic at the rate of 2g, 3g, and 4g/Kg B.W. Sheep were more susceptible to the toxicity than goats.

Two forms of clinical signs were observed: the first form involving the digestive tract and the other form the respiratory system.

The postmortem findings included severe ulcerative abomasitis, friable, congested liver and kidney. Lung oedema and emphysema were observed. Hydropericardium with sub-endocardial haemorrhages and congested brain with slight oedema were seen.

Histopathologically, haemorrhages, infiltration of polymorphonuclear cells and epithelial necrosis of the abomasum were seen. In the heart there was myocardial degeneration with vasodilation and perivascular cuffung. Oedema and emphysema of the lung with pronounced dilatation of the alveolar wall were seen.

Biochemical analysis resulted in a rise in serum concentration of creatinine and urea. Serum GOT and alkaline phosphatase activities were increased. A fall in serum total protein and albumin was found. However, GPT and globulin were not affected. Hb, PCV, RBC values showed a gradual decrease. The results obtained in this study were discussed relating the biochemical with the functional changes.

INTRODUCTION

Cucumis dipsaceus is a member of the family Cucurbitaceae extensively spread in southern and eastern Africa. It is a slender annual climber with pale green stems, branches and long stiff-joined bristles. The leaves are rounded and obscurely toothed. Cucurbitaceae is given by El Awad, (1981).

In the Sudan, the plant is widespread especially in New Haifa where it grows wild among the grasses.

This study was initiated by the complain of livestock owners concerning the toxicity of the plant.

MATERIALS AND METHODS

a) Animals

Sixteen clinically healthy adult animals were used in this experiment: Eight sheep and eight goats. The animals were divided randomly into four groups of four animals each (two sheep & two goats). Animals in group I were left undrenched as controls. Groups II, III, IV were given a dose of 2g/kg, 3g/kg, 4g/kg body weight respectively of a finely minced fresh whole fruits as a suspension in water and administered through a stomach tube each morning for five days. All the animals were provided with lucern and hay and water was supplied ad. lib.

b) Blood and Tissues Sampling

Two blood samples were collected, every morning before drench, from the jugular vein. In one sample heparin was added while the other sample was collected without any anticoagulant and stored at -20°C awaiting analysis. Haemolysed sera was discarded.

At necropsy, samples from kidney, liver, heart, abomasum, intestine and brain were collected in 10% formal-saline, embedded, sectioned and stained with H & E.

c) Haematological and Chemical Methods

Hb (Haemoglobin), PCV (Packed Cell volume) and RBC (Red blood count) were done using the methods described by Sachalm et al., (1975).

Serum aspartate aminotransferase (GOT) and alkaline aminotransferase (GPT) activities were measured by the method of Reitman and Frankel (1957). Serum alkaline-phosphatase (SAP) was measured by the method of Kind and King (1964).

Total protein was determined by Biuret method according to Bartholomew and Delaney, (1964). Globulin was calculated as the difference between the total protein and albumin.

RESULTS

The results obtained are seen in Tables I, II, III & IV. It was noticed that the plant was extremely toxic and the goats were more resistant to the toxicity than sheep. The course of toxicity in sheep ranged from three hours to two days after drench, while the goats might live up to five days even in high doses. The toxicity was characterised by a gradual
decrease in Hb, PCV and RBC values.

a) Clinical Signs

There were two forms of clinical signs. The first form was intestinal, characterised by diarrhoea, weakness, recumbancy and death. The other form was characterised by respiratory distress, distended abdomen, difficulty in respiration, recumbancy and death.

b) Postmortem findings

The postmortem changes consisted of distended abdomen, severe haemorrhagic ulcerative abomasitis (Fig. 2) congested intestinal tract, friable congested kidney and liver. Gall bladder was distended. Subcapsular haemorrhages of the spleen. There was lung oedema and emphysema. The heart was dilated with hydropericardium. Subendocardial haemorrhages were seen. The brain was congested with slight oedema, but the spinal cord, bone marrow and joint were normal. No lesions could be seen in the urinary tract.

c) Histopathological Lesions

Proliferative glomerulo-nephritis was seen in the kidney (Fig. 3). Tubular nephrosis was seen in animals given low doses. The liver cell were degenerated with perportal necrosis (Fig. 4). The abomasum showed haemorrhages, ulcers with infiltration of polymorphonuclear cells (Fig. 5). The heart showed myocardial degeneration (Fig. 6). Oedema and emphysema of the lung with pronounced dilatation of the alveolar wall Fig. 7).

d) Biochemical Analysis

The results showed a rise in the serum concentrations of urea and creatinine. Serum GOT & alkaline phosphatase activities were increased. There was a fall in serum total protein, albumin, PVC, Hb & RBC. However, GPT activity and globulin concentrations were not affected.

DISCUSSION

The present study was conducted to investigated the possible toxic effect of C. dipusaceus fruits to sheep and goats since many complain was received from livestock owners in New Halfa inculminating the plant as causing fatailities among their herds.

The plant was found to be highly toxic in the amounts used in this experiment. Sheep were shown to be more susceptible than goats. The sheep which received 2g, or 3g/kg B.W. died within two days, while the goats given similar doses died after 5 days. This might

| Table 1: Hb., PCV, and RBC of the experimental compared to the control animals. |
|----------------|-------------|-------------|-------------|
|                | Hb. g/100 ml | PCV %       | RBC x 10^6/mm^3 |
| Animals        | 1st. 2nd. 3rd.  4th. 5th. | 1st. 2nd. 3rd.  4th. 5th. | 1st. 2nd. 3rd.  4th. 5th. |
| Group I (Control) |
| sheep 1       | 6.8 6.8 6.9 6.8 7.0      | 24 24 24 23 24      | 8.26 8.54 8.75 8.91 9.12 |
| goats 2       | 6.7 6.5 6.8 6.7 6.8      | 24 24 24 24 22      | 8.43 8.22 8.61 8.89 9.26 |
| Group II given 2g/kg B.W. |
| sheep 3       | 6.9 6.7 6.8 6.7 6.9      | 26 25 25 27 27      | 11.02 11.94 11.82 11.48 11.21 |
| goats 4       | 6.5 6.6 6.9 6.8 6.7      | 24 23 24 22 24      | 8.52 8.34 8.63 8.74 8.92 |
| Group III given 3g/kg B.W. |
| sheep 5       | 6.6 6.7 6.6 6.6 6.7      | 23 20 20 20 20      | 8.63 8.13 8.32 8.21 8.30 |
| goats 6       | 6.7 6.6 6.5 6.4 6.6 6.7  | 24 24 23 22 20 19   | 10.12 9.83 9.23 8.38 10.10 |
| Group IV given 4g/kg B.W. |
| sheep 7       | 6.6 6.4 6.0 6.1 6.8 6.7  | 23 23 21 19 18 16   | 9.37 8.91 8.51 8.34 7.94 |
| goats 8       | 6.6 6.4 6.0 6.1 6.8 6.7  | 23 23 21 19 18 16   | 9.37 8.91 8.51 8.34 7.94 |
| * The animal died. |
Table II: Activities of GOT, GPT, and alkaline phosphatase in the experimental animals serum as compared to the control group.

<table>
<thead>
<tr>
<th>Animals</th>
<th>No.</th>
<th>GOT 1st.</th>
<th>2nd.</th>
<th>3rd.</th>
<th>4th.</th>
<th>5th.</th>
<th>G.P.T. 1st.</th>
<th>2nd.</th>
<th>3rd.</th>
<th>4th.</th>
<th>5th.</th>
<th>Alkaline Phosphatase 1st.</th>
<th>2nd.</th>
<th>3rd.</th>
<th>4th.</th>
<th>5th.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I (Control)</td>
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<td></td>
</tr>
<tr>
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<td>40</td>
<td>38</td>
<td>38</td>
<td>37</td>
<td>8</td>
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<td>38</td>
<td>41*</td>
<td>—</td>
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<td>51*</td>
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<tr>
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<td>sheep</td>
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<td>37*</td>
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<tr>
<td>given 4g/kg bodyweight</td>
<td>sheep</td>
<td>13</td>
<td>42*</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>8*</td>
<td>—</td>
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<td>7*</td>
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<td>43</td>
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<td>7</td>
<td>13</td>
<td>23*</td>
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</tr>
</tbody>
</table>

*The animal died.

Table III: Serum total protein, albumin, and globulin concentrates in the experimental compared to the control groups.

<table>
<thead>
<tr>
<th>Animals</th>
<th>No.</th>
<th>Total protein g/100ml.</th>
<th>Albumin g/100 ml.</th>
<th>Globulin g/100 ml.</th>
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<tr>
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<td>1st. 2nd. 3rd. 4th. 5th.</td>
<td>1st. 2nd. 3rd. 4th. 5th.</td>
</tr>
<tr>
<td>Group I (Control)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sheep</td>
<td>1</td>
<td>7.1 6.9 7.0 7.1 7.3</td>
<td>4.0 3.8 4.0 3.9 3.9</td>
<td>3.1 3.1 3.0 3.2 3.4</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>7.5 7.4 7.5 7.0 7.2</td>
<td>3.9 3.7 3.8 3.6 3.8</td>
<td>3.6 3.7 3.7 3.4 3.4</td>
</tr>
<tr>
<td>goats</td>
<td>3</td>
<td>6.7 6.8 6.6 6.3 6.5</td>
<td>4.2 4.4 4.1 4.0 4.1</td>
<td>2.5 2.4 2.5 2.3 2.4</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>6.5 6.6 6.4 6.7 6.8</td>
<td>4.0 4.2 3.9 4.1 4.0</td>
<td>2.5 2.4 2.5 2.6 2.7</td>
</tr>
<tr>
<td>Group II</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>given 2g/kg B.W.</td>
<td>sheep</td>
<td>6.9 6.5* — — —</td>
<td>3.7 3.6* — — —</td>
<td>3.2 3.2* — — —</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.0 6.2 — — —</td>
<td>3.5 3.0* — — —</td>
<td>3.6 3.2* — — —</td>
</tr>
<tr>
<td>goats</td>
<td>7</td>
<td>6.5 6.1 6.0 5.5 5.2*</td>
<td>4.1 3.5 3.5 3.2 3.0*</td>
<td>2.4 2.6 2.5 2.3 2.2*</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>6.4 6.0 5.7 5.2 4.8*</td>
<td>4.0 3.7 3.3 2.8 2.5*</td>
<td>2.4 2.3 2.4 2.4 2.3*</td>
</tr>
<tr>
<td>Group III</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>given 3g/kg B.W.</td>
<td>sheep</td>
<td>5.8* — — — —</td>
<td>3.4* — — — —</td>
<td>2.4* — — — —</td>
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<tr>
<td></td>
<td>10</td>
<td>6.2* — — — —</td>
<td>3.3* — — — —</td>
<td>2.9* — — — —</td>
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<tr>
<td>goats</td>
<td>11</td>
<td>6.8 6.3 6.0 5.6*</td>
<td>4.2 3.8 3.7 3.2*</td>
<td>2.6 2.5 2.3 2.4*</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>6.6 6.0 5.7 5.3*</td>
<td>4.0 3.5 3.1 2.9*</td>
<td>2.6 2.5 2.6 2.4*</td>
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<tr>
<td>Group IV</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>given 4g/kg B.W.</td>
<td>sheep</td>
<td>6.2* — — — —</td>
<td>3.8* — — — —</td>
<td>2.4* — — — —</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>5.9* — — — —</td>
<td>3.5* — — — —</td>
<td>2.4* — — — —</td>
</tr>
<tr>
<td>goats</td>
<td>15</td>
<td>6.5 6.2 5.5*</td>
<td>3.9 3.5 3.0*</td>
<td>2.6 2.7 2.5*</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>6.7 6.0 5.6*</td>
<td>4.2 3.6 3.1*</td>
<td>2.5 2.4 2.5*</td>
</tr>
</tbody>
</table>

*The animal died.

be due to species differences. Since the fruit is bitter, the animals are not expected to eat it, but the whole plant including the fruits may be hidden in other vegetation or mixed with hay and is mostly eaten unnoticed by the small ruminants.

Work on extraction of the toxic principle of the plant is going on. However, it was reported that the seeds contain saponin (Watt & Breyer-Brandwijk, 1962). The same authors reported that the B-glucosidase elaterase in the Cucurbitaceae is capable of hydrolysing the bitter principles and of splitting of glucose from glucosidases.

Two forms of clinical signs were observed:-

The respiratory distress and diarrhoea. The former may be a consequence of pulmonary congestion and emphysema, whereas the latter
Table IV: Serum urea and creatinine concentrations in the experimental compared to the control groups

<table>
<thead>
<tr>
<th>Animals</th>
<th>No.</th>
<th>Urea conc. mg/100ml</th>
<th>Creatinine Conc. mg/100ml</th>
</tr>
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<tr>
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<td>1st. 2nd. 3rd. 4th. 5th.</td>
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<td>Group I (Control)</td>
<td>1</td>
<td>41 45 43 40 44</td>
<td>0.7 0.6 0.6 0.5 0.7</td>
</tr>
<tr>
<td>Sheep 2</td>
<td></td>
<td>42 40 44 41 43</td>
<td>0.5 0.6 0.7 0.5 0.6</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>41 39 40 42 41</td>
<td>0.6 0.5 0.6 0.6 0.5</td>
</tr>
<tr>
<td>Goats 4</td>
<td></td>
<td>39 36 41 40 43</td>
<td>0.5 0.5 0.6 0.5 0.6</td>
</tr>
<tr>
<td>Group II given 2g/kg B.W.</td>
<td>5</td>
<td>39 44*</td>
<td></td>
</tr>
<tr>
<td>sheep 6</td>
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<td>40 46*</td>
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</tr>
<tr>
<td>goats 8</td>
<td></td>
<td>41 46 49 54 58*</td>
<td>0.4 0.7 0.9 1.1 1.2*</td>
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<tr>
<td>Group III given 3g/kg B.W.</td>
<td>9</td>
<td>41*</td>
<td></td>
</tr>
<tr>
<td>sheep 10</td>
<td></td>
<td>40*</td>
<td></td>
</tr>
<tr>
<td>goats 12</td>
<td></td>
<td>42 49 58 64*</td>
<td></td>
</tr>
<tr>
<td>Group IV given 4g/kg B.W.</td>
<td>13</td>
<td>42*</td>
<td></td>
</tr>
<tr>
<td>sheep 14</td>
<td></td>
<td>40*</td>
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<tr>
<td>goats 16</td>
<td></td>
<td>41 49 68*</td>
<td></td>
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<tr>
<td>15</td>
<td></td>
<td>38 45 59*</td>
<td></td>
</tr>
</tbody>
</table>

* animals died.

was probably due to the extent of the lesion to the intestine.

The development of severe damage to the gastro-intestinal tract is similar to that described by Barri; (1980) in Citrulus colocynthis poisoning to sheep and calves. This may be due to the saponin content of the plant.

The rise in the concentrations of creatinine and urea indicates renal dysfunction. High levels of serum creatinine and urea have also been noticed in goats which had been dosed with copper sulphate (Wasfi & Adam, 1977). The reduced renal function in the animals most probably reduced the excretion of urea by the kidneys.

There was a fall in the concentrations of T.P. and albumin. This is probably due to the

Fig. 1 Fruits of the plant Cucumis dispaceus.

Fig. 2 Severe haemorrhagic ulcerative abomasitis. The one in the far left is normal (control).
Fig. 3: Proliferative glomerulo – nephritis.

Fig. 4: Degerated liver cells with periportal necrosis.
Fig. 5 Haemorrhagic ulcerative abomasitis with polymorpho-nuclear infiltration.

Fig. 6 Heart with myocardial degeneration.

Fig. 7 Lung oedema and emphysema with pronounced dilatation of the alveolar wall.

failure of synthesis by the hepatic cells (Adam, 1974).

The rise in GOT and alkaline phosphatase activities may be due to the liver malfunction. The damage to the kidneys and heart might have contributed to raised GOT levels.

The present work and the studies of Gopinath and Howell, (1975); Ali and Adam, (1978) and Elawad (1981) suggested that serum urea, T.P., Creatinine and GOT estimations were of value in evaluating hepato-renal dysfunction in the small ruminants.

Work is going on the extract the toxic materials from the fruits and more information in needed before a definite conclusion is made as to the pathogenesis, the diagnosis and treatment of the toxicity of this plant.
REFERENCES


Received for publication on 15th June, 1982
THE FEEDING VALUE OF BOILED AND OVEN ROASTED SOYABEAN MEAL FOR BROILER CHICKENS

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Department of Animal Sciences, School of Agriculture, University of Zambia, P.O. Box 32379, Lusaka, Zambia.

SUMMARY

An experiment of a completely randomised block design was conducted using one hundred and twenty six Arbor Acres broiler chickens from one day old to eight weeks of age to determine the feeding value of boiled and oven roasted whole ground soyabean. The seeds were either boiled in water for 15 minutes or roasted in a preheated electrical oven at 121°C for 15 minutes. The processed seeds were ground and incorporated into the experimental starter diets at 24 per cent. During the finishing stage the level boiled or roasted soyabean was increased to 35 per cent to completely replace fish and blood meals used in the starter diets. A commercial broiler diet served as a control.

Boiling seeds in water destroyed 95 per cent of the original trypsin inhibitor activities in raw seeds, oven roasting was only 60 per cent effective. Boiling as a method of seed processing produced superior (P<0.05) performance in terms of growth rate and feed utilisation than oven roasting. The complete replacement of fish meal and blood meal by either boiled or oven roasted ground soyabean resulted in reduced (P<0.05) final body weights and feed efficiency but not in feed intake. Dressing percentage was not affected (P = 0.05) by either method of seed processing or by the complete replacement of fish and blood meals by processed ground soyabean seeds. In general, the observed performance noted on birds fed boiled and roasted ground soyabean was superior (P<0.05) to those obtained on the commercial control boiler diet.

INTRODUCTION

A major factor limiting the production and expansion of the broiler industry in Zambia is feeds. There is only one major stockfeed company located in Lusaka that manufactures the bulk of poultry feed for the entire country. Thus for those farmers who happen to be in rural areas, poultry feeds have been available very irregularly and at very high costs. There exists, however, in these rural areas ingredients that can be used in poultry feed formulations. One such ingredient is soyabean.

The use of soyabean cake in diets of poultry has proved quite successful in North America. Furthermore, in recent years, with the development of new cooking equipment, renewed interest has developed in the feeding of whole cooked soyabean to poultry (Bayley and Summers, 1975). The advantage cited for the use of such a product is the high potential energy and protein content of the seeds thus allowing for higher energy and protein diets to be formulated and the possibility of the seeds being produced and incorporated in an ‘on farm’ mixing programme (Simovic et al., 1972). This experiment was designed to test the effects of some simple processing methods, boiling seeds in water and oven roasting, on the performance of broiler chickens. The experiment also evaluated the efficacy of such processed soyabean as complete substitutes for the rather expensive fish and blood meals as protein sources in the finishing diets of broilers.

MATERIALS AND METHODS

Soyabean were obtained from the University Farm, Liempe. The seeds were cleaned and divided into two batches. One batch was heated in boiling water for 15 minutes and then sun-dried. The other batch was roasted in a pre-heated electric oven at 121°C for 15 minutes. Although this may appear to be impractical under rural farm conditions, it was necessary to have a roaster where temperature could be controlled. The processed seeds were ground to pass through 1mm sieve ready for incorporation into the experimental diets.

Diets

Five diets were used; two from each of either roasted or boiled soyabean and the fifth was a commercial broiler diet obtained from National Milling Company, Lusaka. With the boiled and roasted soyabean, a starter diet designated as (S) and a finisher diet, (F) were formulated (Table 1). Diet (S) were fed to birds during the starter four-week period and to half of the birds during the finisher period from five to eight weeks. Diets (F) were offered to the other half of
birds from five to eight weeks of age but had been on S diets up to the fourth week. The starter diet contained either roasted or boiled soyabean oil at 24 per cent. These diets were fortified with fish meal and blood meal at 4 per cent each. In F diets, all the fish meal and blood meal used in the S diets were replaced with roasted or boiled soyabean oil. In both S and F diets, sunflower meal was included at 20 per cent, dicalcium phosphate at 1 per cent and Nutrafos ‘3’ at 2 per cent. Maize formed the energy source in these rations. Although it was envisaged to use raw soyabean oil as one of the control diets, our preliminary feeding trials indicated nearly 100 per cent mortality on such a diet, hence raw soyabean oil was not used (Ochetim, 1982 unpublished data).

Management

One hundred and twenty six one day old Arbor Acres chickens used in this feeding trial were purchased from Hybrid Poultry Hatchery Farm, Chamba Valley, Lusaka. Birds were randomly divided into eighteen groups consisting of seven birds each. Six replicate groups were assigned to roasted soyabean treatment diet S, six to boiled soyabean treatment diet S and another six groups to commercial broiler diet. At the beginning of the fifth week, three replicate groups from each of the roasted and boiled soyabean treatment diet S were switched on to their respective finisher diets, F. The other three remaining groups on each of roasted and boiled soyabean diets were maintained on starter diets S until the end of the feeding trial at eight weeks of age. The six replicate groups on commercial broiler diet were maintained on the diet from one day of age up to eight weeks. The six replicate groups on commercial broiler diet were maintained on the diet from one day of age up to eight weeks. There is only one type of broiler diet in Zambia.

Birds were maintained on a deep litter floor system with heat provided by infra red lamps during the first two weeks only. The experiment was conducted during the hot summer months, October and November of 1982.

Each group of seven birds was offered feed ad libitum. Water was available from buckets at all times. Birds were weighed at the beginning of the experiment and thereafter weekly until the termination of the feeding trial at eight weeks. At eight weeks of age, three birds randomly selected from each of the replicate groups were starved overnight but with access to water and slaughtered for the determination of carcass yield.

Chemical and statistical analyses

The heat processed ground soyabean seeds were analysed for relative trypsin activities by the method of Kakade et al. (1969). With the exception of Dicalcium phosphate and Nutrafos ‘3’ all the other ingredients and the formulated diets were analysed for proximate principles (A.O.A.C., 1975) and gross energy using an oxygen parr bomb calorimeter. Chick performance and carcass data were subjected to analysis of variance with significant differences shown at the 5 per cent level probability (Steel and Torrie, 1960).

RESULTS

Relative Trypsin Inhibitor Activities

Analysis of the heat processed seeds indicated that boiling seeds in water destroyed 95 per cent of the original trypsin inhibitor activities in raw seeds while oven roasting was only 60 per cent effective.

Mortality

During the course of the trial a mortality of 6.4 per cent was recorded. All the mortality recorded was on the oven roasted soyabean treatment diet and occurred during the second week of the feeding trial. No mortality was recorded on the boiled soyabean treatment diet or the commercial broiler diet'
### Table 1: Formulation and composition of experimental diets

<table>
<thead>
<tr>
<th>DIET</th>
<th>S+</th>
<th>F++</th>
<th>C+++</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Boiled soyabean</td>
<td>Roasted soyabean</td>
<td>Boiled soyabean</td>
</tr>
<tr>
<td>Ingredients, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td>55</td>
<td>55</td>
<td>52</td>
</tr>
<tr>
<td>Boiled soyabean</td>
<td>24</td>
<td>—</td>
<td>35</td>
</tr>
<tr>
<td>Roasted soyabean</td>
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<tr>
<td>Sunflower meal</td>
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</tr>
<tr>
<td>Blood meal</td>
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<tr>
<td>Fish meal</td>
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<td>4</td>
<td>—</td>
</tr>
<tr>
<td>Nutrafos '3'+++</td>
<td>2</td>
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<td>2</td>
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<tr>
<td>Dicalcium phosphate</td>
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<td>1</td>
<td>1</td>
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<tr>
<td>Analysis protein % (6.25xN)</td>
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<td>22.0</td>
<td>21.8</td>
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</tbody>
</table>

+S Starter diet fed to all birds during the first four weeks and to only half the birds during the 5th to 8th week.

+++F Finishing diet fed to half the birds from the 5th to 8th week.

+++F Commercial Broiler diet, National Milling Company, Zambia Ltd.

+++ Nutrafos '3': Commercial mineral — vitamin — antibiotic premix. Composition: Ca 16.2%; P 10.5%; Mg 3.0%; Na 7.2%; Zn 5000 mg; Cu 1250 mg; Mn 3400 mg; 1 20 mg; Co 25 mg; Fe 3750 mg; Vit. A 500,000 IU; Vit. D 100,000 IU; Vit. B₁₂ 660 mcg; Nicotin acid 416 mg; Pantothenic acid 133 mg; Folic acid 20 mg; Choline 2000 mg; Vit. C 100 mg; Flavomycin 300 mg.

### Table 2: Performance of the experimental birds by end of the fourth week

<table>
<thead>
<tr>
<th>DIET</th>
<th>Boiled soyabean</th>
<th>Roasted soyabean</th>
<th>C+</th>
<th>SEM++</th>
</tr>
</thead>
<tbody>
<tr>
<td>Av. wt. of birds, gm</td>
<td>622&lt;sup&gt;a+++&lt;/sup&gt;</td>
<td>500&lt;sup&gt;b&lt;/sup&gt;</td>
<td>372&lt;sup&gt;c&lt;/sup&gt;</td>
<td>46</td>
</tr>
<tr>
<td>Av. feed consumption, gm</td>
<td>1017&lt;sup&gt;a&lt;/sup&gt;</td>
<td>970&lt;sup&gt;a&lt;/sup&gt;</td>
<td>980&lt;sup&gt;c&lt;/sup&gt;</td>
<td>62</td>
</tr>
<tr>
<td>Feed to gain ratio</td>
<td>1.75&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.12&lt;sup&gt;b&lt;/sub&gt;</td>
<td>2.96</td>
<td>0.13</td>
</tr>
</tbody>
</table>

+C Commercial broiler diet, National Milling Company, Zambia Ltd.

++SEM Standard error of the treatment means

+++ Treatment means with different superscripts are different (P<0.05)

### Table 3: Performance of experimental birds for starter diet eight weeks of age

<table>
<thead>
<tr>
<th>DIET</th>
<th>Boiled soyabean</th>
<th>Roasted soyabean</th>
<th>Commercial Broiler diet</th>
<th>SEM+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weight, kg</td>
<td>1.76&lt;sup&gt;a++&lt;/sup&gt;</td>
<td>1.56&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.21&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.23</td>
</tr>
<tr>
<td>Average feed intake, kg</td>
<td>3.91&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.88&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.30&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.43</td>
</tr>
<tr>
<td>Feed to gain ratio</td>
<td>2.22&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.46&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.55&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.35</td>
</tr>
<tr>
<td>Dressing percentage</td>
<td>68.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>69.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>67.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.20</td>
</tr>
</tbody>
</table>

++ SEM standard error of treatment means

++ Treatment means with different superscripts are different (P<0.05)
Growth Rate, Feed Intake, Feed Efficiency and Dressing Percentage

Data on growth rate, feed intake and feed efficiency during the first four weeks, the starter period, are presented in Table 2. At the end of the fourth week, chicks receiving boiled soyabean diet were 24.4 per cent heavier and 17.8 per cent more efficient in feed conversion than those on roasted soyabean diet. These differences were significant (P < 0.05). Although feed intake was higher by 3.9 per cent on boiled than roasted soyabean diet, the difference was not significant (P > 0.05). However, the observed body weights, feed intake and feed efficiency on the commercial broiler diet were all inferior (P < 0.05) to those noted on roasted and boiled soyabean diets.

Considering only those birds fed boiled and roasted soyabean starter S diets at the end of the eighth week, those fed boiled soyabean diet were on the average 1.76kg while those on roasted soyabean were 1.53kg, (Table 3). These final body weights were found to be different (P < 0.05). Similarly, feed efficiency but not feed intake was superior (P < 0.05) on boiled compared to roasted soyabean starter S diets. Again, the performance of chicks on commercial diet were found to be inferior (P < 0.05) to the two soyabean starter S diets.

Complete replacement of fish meal and blood meal in finisher diet by boiled or roasted soyabean resulted in reduced final body weights; 1.76 vs 1.67 kg and 1.58 vs 1.36 kg; lowered feed consumption 3.91 vs 3.88 kg and 3.88 vs 3.76 kg; and decreased feed utilisation 2.22 vs 3.32 and 2.46 vs 2.76 on the boiled and roasted soyabean S and F diets, respectively (Tables 4 and 5). For each dietary treatment group, the reductions in final body weights and feed efficiencies were significant (P < 0.05) but not feed intake and dressing percentage. Inspite of the reductions in the performance of broiler chickens by the complete replacement of fish and blood meals from the finisher F diets, the performance of birds fed boiled soyabean diet was still in general superior to those offered the roasted soyabean diet (Table 6). Birds fed the commercial broiler diet had inferior (P < 0.05) performance in terms of final body weight, feed efficiency and feed consumption. However, no significant (P < 0.05) differences existed in dressing percentage on all treatment groups.

DISCUSSION

Results obtained indicated that boiling seeds in water produced superior performance when compared to oven roasting method. Seeds were boiled in water for 15 minutes while oven roasting was done at 121°C for 15 minutes. The objective in heat processing of soyabean is to destroy the toxic principles, mainly trypsin inhibitors, that are present in raw seeds. However, care is also normally taken to ensure that while destroying the toxic principles, the quality of the protein is not adversely affected (Ochetim and Nicholson, 1978). Trypsin inhibitors are known to adversely affect the performance of simple-stomached animals in terms of growth rate, feed utilisation, nutrient digestibility and the functioning of some internal organs such as the pancreas and liver (Lienen, 1962; Ochetim and Bogere, 1979). Boiling seeds in water destroyed 95 per cent of trypsin inhibitor activities while roasting was only 60 per cent effective. The relative ineffectiveness of oven roasting method in destroying trypsin inhibitor activities was probably related to poor heat transfer within the seed (Simovic et al., 1972). According to Lienen (1962), the destruction of trypsin inhibitors is controlled principally by temperature, moisture, time and particle size. Heat transfer through the seed is poor under conditions of low moisture content even if temperatures are kept high (Ochetim and Bogere, 1979; Simovic et al., 1972). This is due to the fact that dry heat is less effective in destroying trypsin inhibitor activities than moist heat, at given temperature and for an equal length of processing time. Although roasting was carried at a higher temperature than boiling, it was initially felt that a higher temperature and/or processing time might impair protein quality of the seeds. The difference in the residual trypsin inhibitor activities must have largely accounted for the
Table 4: Performance of experimental birds fed boiled soyabean diets with or without fish and blood meals

<table>
<thead>
<tr>
<th></th>
<th>Boiled soybeans with blood and fish meals</th>
<th>Boiled soybeans without blood and fish meals</th>
<th>Commercial Broiler Diet</th>
<th>SEM+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average body weight, kg</td>
<td>1.76a**</td>
<td>1.67b</td>
<td>1.21c</td>
<td>0.27</td>
</tr>
<tr>
<td>Average feed intake, kg</td>
<td>3.91a</td>
<td>3.88a</td>
<td>4.30b</td>
<td>0.45</td>
</tr>
<tr>
<td>Feed to gain ratio</td>
<td>2.22a</td>
<td>2.32b</td>
<td>3.55c</td>
<td>0.36</td>
</tr>
<tr>
<td>Dressing percentage</td>
<td>68.8a</td>
<td>67.1a</td>
<td>67.8a</td>
<td>0.95</td>
</tr>
</tbody>
</table>

** SEM Standard error of treatment means. 
++ Treatment means with different superscripts are different (P<0.05).

Table 5: Performance of experimental birds fed roasted soyabean with or without fish and blood meals

<table>
<thead>
<tr>
<th></th>
<th>Roasted soybeans with fish and Blood meals</th>
<th>Roasted soybeans without fish and blood meals</th>
<th>Commercial Broiler Diet</th>
<th>SEM+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average body weight kg</td>
<td>1.58a++</td>
<td>1.36b</td>
<td>1.21c</td>
<td>0.23</td>
</tr>
<tr>
<td>Average feed intake kg</td>
<td>3.88a</td>
<td>3.76a</td>
<td>4.30b</td>
<td>0.48</td>
</tr>
<tr>
<td>Feed to gain ratio</td>
<td>2.46a</td>
<td>2.76b</td>
<td>3.55c</td>
<td>0.39</td>
</tr>
<tr>
<td>Dressing percentage</td>
<td>69.0a</td>
<td>67.5a</td>
<td>67.8a</td>
<td>1.03</td>
</tr>
</tbody>
</table>

** SEM Standard error of treatment means. 
++ Treatment means with different superscripts are different (P<0.05).

Table 6: Performance of experimental birds fed boiled or soyabean diets without fish and blood meals

<table>
<thead>
<tr>
<th></th>
<th>Boiled soybean diet</th>
<th>Roasted soybean diet</th>
<th>Commercial Broiler diet</th>
<th>SEM+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average body weight, kg</td>
<td>1.67a++</td>
<td>1.36b</td>
<td>1.21c</td>
<td>0.28</td>
</tr>
<tr>
<td>Average feed intake, kg</td>
<td>3.88a</td>
<td>3.76a</td>
<td>4.30b</td>
<td>0.48</td>
</tr>
<tr>
<td>Feed to gain ratio</td>
<td>2.32a</td>
<td>2.76b</td>
<td>3.55c</td>
<td>0.39</td>
</tr>
<tr>
<td>Dressing percentage</td>
<td>67.1a</td>
<td>67.5a</td>
<td>67.8a</td>
<td>0.95</td>
</tr>
</tbody>
</table>

** SEM Standard error of treatment means. 
++ Treatment means with different superscripts are different (P<0.05).
observed differences in broiler performance. The observed reduction in performance of chicks fed high residual trypsin inhibitor activities noted in our trial concurs with those of Bayley and Summers, (1975). Further work is, however, underway on methods of improving soyabean roasting by steam injection, milling seeds prior to roasting and soaking seeds in water before roasting.

The complete replacement of the animal protein sources, fish and blood meals, by either boiled or roasted soyabean resulted in the reduction of broiler performance. Although the substitutions were made on a nitrogen level basis such that diets remained isonitrogenous, the inferior performance noted on diets without the two animal protein sources suggests that soyabean protein has a lower protein feeding value than fish and blood meal. According to Fox et al. (1958), the availability of amino acids from soyabean meal is lower than those from fish meal and blood meal. Furthermore, the higher level of inclusion of soyabean meal at the expense of blood meal and fish meal must have lowered the methionine and cystine contents in such diets. Soyabean meal is deficient in sulphur containing amino acids (Jensen et al., 1975). The overall effect would be not only a lowering of the sulphur amino acid contents in the diets but also reduced availability of total amino acids. These factors must have been responsible for the adverse effects noted when both fish meal and blood meal were completely replaced by either boiled or roasted soyabean.

It can be concluded from this study that boiling soyabean seeds in water for 15 minutes is a more effective method of destroying trypsin inhibitor activities in the seeds than oven roasting at 121°C for 15 minutes. Further more, such boiled seeds produce better broiler performance than oven roasting. However, the complete replacement of fish meal and blood meal in broiler diets by boiled or roasted soyabean tends to impair broiler performance.

ACKNOWLEDGEMENTS

Thanks are due to Refined Oil Products, ROP, Zambia Ltd', (1975) for providing sunflower cake and to Cold Storage Board of Zambia for supplying blood meal. The assistance provided by J. Griffin and K. Kaoma during feed mixing and care of chicks is highly appreciated. Many thanks are also due to M. Mooto for feed analysis.

REFERENCES


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POULTRY MANURE AS A FEEDSTUFFS FOR RUMINANTS: II: Effects of ensilage on pathogens, nutrients and odour of diets based on caged layer excreta

F.K. FIANU, F.K.G. ASSOKU and F. HINSON
Department of Animal Sciences, University of Ghana, Legon, Accra, Ghana

SUMMARY

Three diets containing 10%, 20% or 30% caged layer excreta (CLE) were formulated. Half kilogram aliquots of each diet were ensiled in polythene bags, packed into concrete culverts. Randomly, one bag of each diet was taken weekly for pH determination, microbial count, proximate analysis and subjective odour evaluation over a period of six weeks.

Crude protein (CP) of the fresh CLE was 27.6%, crude fibre (CF) 11.2%, ether extract (EE) 2.4%, ash 39.3% and nitrogen-free extractives (NFE) 19.5%. The diets contained 8.7-10.9% CP, 18.0-18.7% CF, 1.9-2.8% EE, 11.0-13.4% Ash, 56.0-56.6% NFE, and 4.1-4.2 Kcal/g Gross Energy (GE). During ensilage, CP, CF, NFE and GE remained stable, while EE increased by 0.6-0.8 percentage points, and ash dropped by 1.5-2.9 points. The dietary formulations greatly reduced the objectionable odour associated with CLE, while the ensilage process imparted a pleasant aroma to the diets.

The predominant bacteria in the diets were Bacillus, E. coli, Corynebacterium, Clostridium, Klebsiella, Micrococcus, Neisseria, Staphylococcus and Streptococcus. There was also profuse growth of yeast. Ensiling readily eliminated Clostridium, Micrococcus and Neisseria, while Streptococcus and Bacillus species were the most resistant. Yeasts however, were not affected by ensilage.

INTRODUCTION

The potential of poultry manure as a nitrogen supplement in the diet of ruminants has been reviewed widely (El-Sabban et al., 1970; Gohl, 1970; Bull and Reid, 1971; Fontenot et al., 1971). Among the problems in the use of this feedstuff is its offensive odour, pathogen hazard, nitrogen volatilisation, heavy metal toxicity, drugs and pesticide residues. Heavy metal toxicity and residue of drugs and pesticides are controllable through the dietary regime and management of the chickens from which the manure is obtained. Similarly, objectionable odours, pathogens and nitrogen losses may be controlled by feeding chickens with odour suppressants, and by heating, dehydrating, ensiling and chemical treatment of manure (Bressler and Bergman, 1971; Scholtz, 1971; Smith et al., 1978).

In the quest for appropriate technology in developing countries for poultry manure treatment, trials were conducted recently with laboratory-scale autoclaving, overheating and air-drying. It was found that none of these methods was satisfactory for the simultaneous control of odour, pathogens and nutrient loss. This was at variance with earlier data obtained with sophisticated plants. The high costs of such plants render them unsuitable for developing countries. Chemical treatment also poses the problems of cost and unavailability of the chemicals. Ensiling, on the other hand, seems to be an alternative inexpensive treatment, with little or no import input.

In this study, three diets, formulated with caged layer manure, were ensiled and evaluated for odour, pathogens, pH and proximate composition.

MATERIALS AND METHODS

Three iso-nitrogenous diets were formulated as shown in Table 1 to give a calculated CP content of 12%. Seven lots, each weighing about 500g, were made of each diet and ensiled in heavy duty polythene bags (0.15mm thickness), measuring 18 x 50 cm. Each polythene bag was rolled tight to expel air. All bags were then packed into concrete culverts, 0.8m in diameter and 1m high, covered with straw and weighted down with cement blocks. Each week, one bag was taken out at random from

<table>
<thead>
<tr>
<th>INGREDIENT</th>
<th>DIETS 1</th>
<th>DIETS 2</th>
<th>DIETS 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caged Layer Manure</td>
<td>10.0</td>
<td>20.0</td>
<td>30.0</td>
</tr>
<tr>
<td>Copra Cake</td>
<td>12.5</td>
<td>11.6</td>
<td>—</td>
</tr>
<tr>
<td>Maize</td>
<td>36.0</td>
<td>24.7</td>
<td>20.0</td>
</tr>
<tr>
<td>Straw</td>
<td>31.0</td>
<td>30.4</td>
<td>30.0</td>
</tr>
<tr>
<td>Molasses</td>
<td>10.0</td>
<td>13.0</td>
<td>19.5</td>
</tr>
<tr>
<td>*Vitamin-Mineral Mix</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

*Vitamin-mineral mix containing Vit. A-D., Ca, P, NaCl., and trace minerals.

Table 1: Composition of diets ensiled (%)
each diet for determination of pH, microbial count, proximate composition, and subjective assessment of odour.

The pH was determined according to standard procedure (AOAC, 1970). Microbial examination were made by methods outlined by Benson (1978) and Collins and Lyne (1970). Media used for plating were blood agar and McConkey, incubating under aerobic and anaerobic conditions. The anaerobic atmosphere was obtained by burning a candle in a grease-sealed 24cm-gas jar enclosing the specimen. Gram and Ziehl-Neelson's stains were used, and methyl-red and malonate tests were employed to confirm examinations under the microscope. Bacterial counts were made using the Quebec Colony Counter.

RESULTS

Proximate composition: The proximate composition of the fresh manure and the diets before ensiling is given in Table 2. The fresh manure contained 27.6% crude protein (CP), 11.2% crude fibre (CF), 2.4% ether extracts (EE), 39.3% ash and 19.5% nitrogen-free extractives (NFE). The diets contained 8.7%-10.9% CP, 18.0-18.7% CF, 1.9-2.8% EE, 11.0-13.4% ash and 56% NFE; gross energy (GE) was 4.1-4.2 Kcal/g. After ensiling, the CP range was 8.2-10.6%, CF was 15.8-18.9%, EE was 2.7-3.4%, while ash and NFE were 8.1-11.9% and 57.8-61.4% respectively and GE was 4.1-4.4 Kcal/g. Thus, there was little change in CP, CF, NFE and GE during ensilage. Ether extracts, however, increased by 25-40%, while ash dropped (Table 3).

Odour and pH: Malodour was abated but not completely eliminated by mixing the manure with the various ingredients. The ensiling process, however, removed all traces of the malodour of manure and imparted a pleasant aroma to the diets. The pH of fresh manure was 6.2, while the pH of the three diets before ensiling were 5.7, 5.8 and 6.5 for diets 1, 2 and 3, respectively. A rapid drop in pH occurred during ensilage (Table 3). After one week, the pH averaged 4.23 and thereafter, the decline was slower, reaching 4.02 after six weeks of fermentation.

Microbial examination: Bacterial counts were higher in diets containing higher proportions of manure (Table 4). Thus, before ensiling, the aerobic counts were $14 \times 10^6$, $83 \times 10^6$ and $150 \times 10^6$ per gram, respectively, for diets 1, 2 and 3 which contained 10, 20 and 30% manure in that order. The corresponding figures for anaerobes were 5, 9 and 15 million per gram, respectively. By the end of week 1, the aerobes had dropped by 14, 81 and 61 percent for diets 1, 2 and 3 in that order. By the end of the second week the aerobic counts had dropped by 86%, 96% and 92%, and in week 3 only diet 3 had traces of aerobic bacteria. On the other hand, anaerobes increa-

| Table 2: Proximate composition of caged-layer excreta, straw and the three diets before and after ensiling. |
|---------------------------------|----------|----------|--------|--------|--------|--------|--------|
|                                 | % DM    | % CP     | % CF   | % EE   | % ASH  | % NFE  | (Kcal/g) |
| Fresh Manure                    |         |          |        |        |        |        |          |
| Straw                           | 27.6    | 27.6     | 11.2   | 2.4    | 39.3   | 39.5   |          |
|                                | 71.1    | 4.0      | 44.1   | 2.1    | 8.0    | 42.0   |          |
| Before Ensiling:                |         |          |        |        |        |        |          |
| Diet 1                          | 58.1    | 10.4     | 18.7   | 2.5    | 12.3   | 56.2   | 4.1      |
| Diet 2                          | 52.0    | 10.9     | 18.7   | 2.8    | 11.0   | 56.6   | 4.2      |
| Diet 3                          | 51.4    | 8.7      | 18.0   | 1.9    | 13.4   | 56.0   | 4.2      |
| After Ensiling:                 |         |          |        |        |        |        |          |
| Diet 1                          | 55.7    | 10.6     | 18.9   | 3.3    | 9.4    | 57.8   | 4.4      |
| Diet 2                          | 50.0    | 10.4     | 18.8   | 3.4    | 8.1    | 59.3   | 4.2      |
| Diet 3                          | 48.8    | 8.2      | 15.8   | 2.7    | 11.9   | 61.4   | 4.1      |
Table 3: Changes in pH of silage made from diets based on caged-layer excreta.

<table>
<thead>
<tr>
<th>WEEK OF ENSILING</th>
<th>DIET 1</th>
<th>DIET 2</th>
<th>DIET 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5.7</td>
<td>5.8</td>
<td>6.5</td>
</tr>
<tr>
<td>1</td>
<td>4.2</td>
<td>4.2</td>
<td>4.3</td>
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<td>4.0</td>
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<td>4.4</td>
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<td>4.3</td>
</tr>
<tr>
<td>6</td>
<td>4.2</td>
<td>3.75</td>
<td>4.1</td>
</tr>
</tbody>
</table>

sed markedly in the first 2-3 weeks. Thus, the counts increased by 60, 255 and 166 percent in week 1, and 100, 544 and 553 percent by the end of week 2 (Table 4). In diet 1, the count shot up by 1,400 percent in week 3 before dropping to thrice the initial count in week 4, while in diets 2 and 3 decline in anaerobic populations started in week 3. In all diets, bacterial counts continued to fall till the end of the week 6 when the counts were 100 percent more in diet 1, and 50 and 53 percent less in diets 2 and 3, respectively, compared to the initial contents.

The major bacteria in the fresh caged layer manure included species of Bacillus, Corynebacterium, Clostridium, E. coli, Klebsiella, Micrococcus, Neisseria, Staphylococcus and Streptococcus, in addition to yeasts (Table 5). No Salmonella and Pasteurella were recorded. Yeasts, although aerobic, were not affected by increasing anaerobiosis with the passage of time or by the declining pH (Table 5). Bacillus and Streptococcus species were also less affected.

Table 4: Counts of aerobic and anaerobic organisms in silages made from diets based on caged-layer manure, (x 10⁶/g).

<table>
<thead>
<tr>
<th>WEEK OF ENSILING</th>
<th>AEROBES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DIETS</td>
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<td>DIETS</td>
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<td>1</td>
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<td>0</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 5: Changes in microbial counts during ensilage of diets based on caged-layer excreta

<table>
<thead>
<tr>
<th>WEEK OF ENSILING</th>
<th>Clostridium</th>
<th>Micrococcus</th>
<th>Neisseria</th>
<th>Corynebacterium</th>
<th>Staphylococcus</th>
<th>E. Coli</th>
<th>Klebsiella</th>
<th>Streptococcus</th>
<th>Bacillus</th>
<th>Yeast</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>+++</td>
<td>**</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
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</table>
than the other bacteria, although they declined with the passage of time. *Clostridium* and *Micrococcus* species disappeared within one week of ensiling. *Neisseria* in week 2, and *Staphylococcus* and *Corynebacterium* by the end of the week 3. By the end of week 5, *E. coli* and *Klebsiella* had also disappeared (Table 5).

**DISCUSSION**

These figures are similar to data reported by other workers. However the ash is higher, and consequently the NFE is lower than the data published by Bhattacharya and Taylor (1975), and Smith and MacLeod (1979). The CP is also slightly lower than the 36.9% reported by Bull and Reid (1971) and the 42.5% by Fontenot *et al.* (1971). The latter also reported high ash content and low NFE values.

On the whole, the ensilage process preserved nutrients very well as there was little change in CP, CF, NFE and CE. This confirms the conclusion of Buchanan-Smith *et al.* (1974) who ensiled poultry manure with maize grain, and of Albert, *et al.* (1977) who ensiled mixtures of caged layer manure and maize forage.

Increases in EE during ensilage probably arose from decarboxylation of amino acids which is favoured by anaerobiosis at low pH and is accompanied by the production of fatty acids (White *et al.*, 1971); some lipid synthesis may also take place. The fall in ash, on the other hand, was unexpected.

The deodorising effect of ensilage on poultry manure has been reported by Buchanan-Smith *et al.* (1974), Albert *et al.* (1977) and by Arndt, *et al.* (1979). Arrest of deamination by anaerobiosis, and a fall in pH (White *et al.*, 1971), together with the formation of lactic and acetic acids during ensilage (McDonald and Whittenbury, 1973), and possibly a breakdown of the skatole, indole and other odorous compounds, may account for the deodorisation. The arrest of deamination is reflected in the preservation of CP (Table 4). Although H₂S production was not monitored, its characteristic odour was noticeably absent. Since H₂S formation occurs at low pH under anaerobiosis (White *et al.*, 1971; Mc Calla & Elliott, 1971), this gas might have been further metabolised. The sweet silage aroma generated by lactic acid may also have helped to mask any residual malodour.

A drop in pH of ensiled material is characteristic of good ensilage (McDonald and Whittenbury, 1973; Flipot *et al.*, 1975). Smith *et al.*, (1978) obtained a pH of 7.0 for poultry manure treated with organic acids and found that as the material became putrid and ammonia-N rose, the pH rose to over 8. Thus, the drop in pH found in the three diets was salutary. The initial high pH of diet 3 (6.5), compared with fresh manure which had a pH of 6.2, may have been due mainly to deamination and uric acid decomposition during handling prior to processing. Notwithstanding this initial high value, the pH of the ration fell to 4.2 during ensilage.

The rapid disappearance of aerobic bacteria and proliferation of anaerobes agree with expected microbial changes in good silage as air get depleted in the silage (McDonald and Whittenbury, 1973). Although yeasts are aerobic, they persisted in anaerobiosis by forming spores and by tolerance to low pH and high osmotic tension (Pelczar, *et al.*, 1980). On the other hand, *Clostridium* which is an anaerobe, disappeared quickly despite the onset of anaerobiosis. This may have been due partly to pH and also partly to the high osmotic tension in the silage (i.e. dry matter content of about 50%). The drop in the pH to 4.2-4.3 in week 1 seemed to have been low enough to kill this organism. This finding agrees with the report by McDonald and Whittenbury (1973), who found that at low moisture levels, the pH of 4.2 killed *Clostridium*, whereas at high moisture levels, the pH drop required to eliminate *Clostridium* was of the order of 3.5-3.75. *E. coli*, *Klebsiella*, *Corynebacterium*, *Streptococcus*, and *Bacillus* persisted for 3 to 6 weeks because of the probability that they are all facultative anaerobes; their eventual decline could also be attributed to the fall in the pH. The species that proved most susceptible to low pH was *Corynebacterium*, followed by the coliforms: *E. coli* and *Klebsiella*, while *Bacillus* and *Streptococcus* were the most resistant organisms.
The absence of Pasteurella from the fresh manure does not agree with data reported by Alexander et al., (1968). However, the absence of Salmonella in the specimens agrees with Kraft et al., (1969) who reported Salmonella to be absent from 71% samples of fresh poultry manure from 36 farms, and with Smith et al., (1979) who found a low incidence of Salmonella in caged poultry manure. Furthermore, Salmonella seems to be readily eliminated during storage (Taylor, 1971; Kraft et al., 1969; Smith et al., 1978), by organic acids (Smith et al., 1979), and by ensiling (Taylor, 1971). Thus, data obtained in this study seemed to show that the problems of nutrient losses, offensive odour and pathogens associated with caged layer excreta could be solved by ensiling formulated diets.

ACKNOWLEDGEMENTS

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PREVALENCE, SEASONAL VARIATION AND ECONOMIC SIGNIFICANCE OF FASCIO-LISTS IN CATTLE AS OBSERVED AT IRINGA ABATTOIR BETWEEN 1976 AND 1980

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SUMMARY

Monthly and annual records of meat inspection from Iringa abattoir compiled between 1976 and 1980 were scrutinized with a view of re-examining the prevalence, seasonal variation and economic significance of fasciolasis (Fasciola gigantica) in cattle. The mean annual prevalence was 36.5 per cent. The mean prevalence during the rainy and dry months were respectively 35 and 36%. It was estimated that, annually, there is on the average, a monetary loss of 9,608.74-16,556.20 U.S.A. dollars as a result of condemnation of bovine livers infected with fasciolasis.

INTRODUCTION

Fasciola gigantica, is by and large, the most commonly occurring liver helminth of cattle in Tanzania. Data available at the Veterinary Investigation Centre, Iringa, for examples, indicate that 99.9% of fasciolasis cases in cattle in Iringa region are due to Fasciola gigantica. Hammond (1965) has reported that this helminth is enzootic in all districts of Tanganyika with a mean rainfall of 40 inches.

The intermediate host of Fasciola gigantica is the equatic snail Lymnea natalensis. This snail is widely distributed in Tanzania and in the other East African countries. The most valuable work about the distribution of this snail in East Africa has been done by Dinnik and Dinnik (1956; 1963; 1964), who have described the snail in various ecological spheres.

National losses by fasciolasis in cattle are reported to be tremendous and figures from meat inspection on condemnation of cattle livers indicate that the losses are permanently on the increase (Mahlau, 1981). This study was undertaken to re-examine the prevalence of Fasciola gigantica in cattle of Iringa district with the aim of high-lighting the monetary losses incurred as a sequel of liver condemnations.

MATERIALS AND METHODS

Records of meat inspection available at the District Livestock Development Office, Iringa, were used for this study. Monthly and annual returns from the abattoir inspected by skilled Veterinary meat inspectors were studied in regard to total cattle slaughtered and the corresponding number of livers condemned due to fasciolasis.

Seasonal fluctuations in the prevalence were examined by pooling respective monthly condemnation data over the five year (1976-1980) period. To gain an insight into the variation related to either rain or drought the mean prevalence for each period was determined and subsequently the two means were compared.

The monetary loss was estimated basing the calculation on the current price 17 T.Shs. per kg of liver. The mean weight of the bovine liver in the market was determined basing the calculation on the weights (kg) of 10 bovine livers obtained from different butchers in Iringa town. The weights of the condemned livers were estimated basing the calculation on the weight range of the liver; the range having been computed from the mean liver weight using the respective standard deviation.

Means and standard deviations were calculated by conventional methods and compared by Student’s t-test (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

The results of the prevalence and the seasonal variation in the prevalence of fasciolasis in cattle as observed at Iringa abattoir between 1976 and 1980 are given in tables 1 and 2 respectively. On the whole, the percentage of infection over the years examined varied from approximately, 27 to 47 (Table 1); with a mean prevalence rate (%) of 36.5 (±8.5). The prevalence of the helminth through most of the seasons was fairly constant (Table 2); the mean
Table 1: Prevalence of *Fasciola gigantica* in cattle at Iringa abattoir between 1976 and 1920(1).

<table>
<thead>
<tr>
<th>Year</th>
<th>Total cattle slaughtered</th>
<th>Mean (±sd) cattle slaughtered</th>
<th>Total Fascioliasis cases</th>
<th>Mean (±sd) Fascioliasis cases</th>
<th>Prevalence %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1976</td>
<td>8651</td>
<td>720.9(±59.81)</td>
<td>2624</td>
<td>218.7(±27.77)</td>
<td>30.3</td>
</tr>
<tr>
<td>1977</td>
<td>6664</td>
<td>555.3(±130.00)</td>
<td>1811</td>
<td>150.9(±66.20)</td>
<td>27.2</td>
</tr>
<tr>
<td>1978</td>
<td>4636</td>
<td>386.5(±79.93)</td>
<td>2046</td>
<td>170.5(±40.60)</td>
<td>44.1</td>
</tr>
<tr>
<td>1979</td>
<td>6924</td>
<td>577.0(±103.83)</td>
<td>3225</td>
<td>268.7(±75.95)</td>
<td>46.6</td>
</tr>
<tr>
<td>1980</td>
<td>7576</td>
<td>631.3(±73.76)</td>
<td>2607</td>
<td>217.2(±59.38)</td>
<td>34.4</td>
</tr>
</tbody>
</table>

(1) Calculations of mean in each year was based on twelve monthly observations.

sd = standard deviation.

Table 2: Seasonal variation in the prevalence of *Fasciola gigantica* in cattle at Iringa abattoir between 1976 and 1980(1).

<table>
<thead>
<tr>
<th>Season (month)</th>
<th>Total cattle slaughtered</th>
<th>Mean (±sd) cattle slaughtered</th>
<th>Total Fascioliasis cases</th>
<th>Mean (±sd) Fascioliasis cases</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>2699</td>
<td>538.6(±202.55)</td>
<td>944</td>
<td>188.8(±46.64)</td>
<td>35.01</td>
</tr>
<tr>
<td>February</td>
<td>2521</td>
<td>504.2(±109.22)</td>
<td>997</td>
<td>199.4(±17.15)</td>
<td>39.5</td>
</tr>
<tr>
<td>March</td>
<td>2984</td>
<td>596.8(±105.99)</td>
<td>1018</td>
<td>203.8(±10.24)</td>
<td>34.1</td>
</tr>
<tr>
<td>April=</td>
<td>2836</td>
<td>567.2(±112.79)</td>
<td>1096</td>
<td>219.2(±33.09)</td>
<td>38.6</td>
</tr>
<tr>
<td>May</td>
<td>3067</td>
<td>613.4(±91.53)</td>
<td>1288</td>
<td>257.6(±73.25)</td>
<td>42.0</td>
</tr>
<tr>
<td>June</td>
<td>3042</td>
<td>608.4(±93.45)</td>
<td>1193</td>
<td>238.6(±63.84)</td>
<td>39.2</td>
</tr>
<tr>
<td>July</td>
<td>3071</td>
<td>614.2(±126.70)</td>
<td>926</td>
<td>185.2(±64.64)</td>
<td>30.1</td>
</tr>
<tr>
<td>August</td>
<td>3000</td>
<td>600.0(±138.65)</td>
<td>909</td>
<td>181.8(±78.43)</td>
<td>30.3</td>
</tr>
<tr>
<td>September</td>
<td>2962</td>
<td>592.4(±186.19)</td>
<td>1103</td>
<td>220.6(±97.48)</td>
<td>37.2</td>
</tr>
<tr>
<td>October</td>
<td>2842</td>
<td>568.4(±224.29)</td>
<td>1056</td>
<td>211.2(±131.67)</td>
<td>37.2</td>
</tr>
<tr>
<td>November*</td>
<td>2716</td>
<td>543.2(±196.52)</td>
<td>838</td>
<td>167.6(±54.81)</td>
<td>30.8</td>
</tr>
<tr>
<td>December</td>
<td>2716</td>
<td>543.4(±171.73)</td>
<td>945</td>
<td>189.0(±85.83)</td>
<td>34.8</td>
</tr>
</tbody>
</table>

(1) Calculation of mean in each season was based on five observations (i.e. 5 Januaries, 5 Decembers, etc).

sd = standard deviation; * Start of rains; == End of rains.

Prevalence (%) during the dry (May-October) and rainy (November-April) seasons being respectively 36.0 (±4.82) and 35.5 (±3.17).

*Fasciola gigantica* infection rates in cattle are reported to be high during the dry season and low during the rainy season (Mahlau, 1970; Ecimovic and Mahlau, 1973). The data on the seasonal variation in the prevalence rate of the fluke in cattle (Table 2), does support the rate to be high at the start of the dry season (May) and low at the start of the rainy season (November). However, the mean prevalence rates of the two seasons don't differ significantly ($t_{(10)} = 0.322; P > 0.05$) possibly because the data is rather too small.

The prevalence of bovine fascioliasis in Iringa district in the past five years (1971-1975) is given in table 3. The mean prevalence rate of the disease over this period was found to be 30.1% ± 13.6%. When the mean prevalence rate of the disease for the 1971-1975 period was compared with that for the 1976-1980 period it was found that the two mean prevalence rates did not differ significantly from one another ($t_{(8)} = 2.206; P > 0.05$). This finding therefore, supported a previous report (Mahlau, 1981), that the losses due to Fascioliasis in the liverfluke enzootic districts of Tanzania are permanently on the increase.
Table 3: Prevalence of *Fasciola gigantica* in cattle at Iringa abattoir between 1971 and 1975.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total cattle slaughtered</th>
<th>Total Fascioliasis cases</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971</td>
<td>7,450</td>
<td>1,340</td>
<td>18.0</td>
</tr>
<tr>
<td>1972</td>
<td>7,074</td>
<td>1,297</td>
<td>18.3</td>
</tr>
<tr>
<td>1973</td>
<td>8,369</td>
<td>3,021</td>
<td>36.1</td>
</tr>
<tr>
<td>1974</td>
<td>9,113</td>
<td>4,605</td>
<td>50.5</td>
</tr>
<tr>
<td>1975</td>
<td>7,450</td>
<td>2,130</td>
<td>28.6</td>
</tr>
</tbody>
</table>

Table 4: The number of condemned livers and the monetary loss resulting from the condemnation due to *Fasciola gigantica* in cattle at Iringa abattoir between 1976 and 1980.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Condemned livers</th>
<th>Estimated Weight (Kg) of Condemned livers</th>
<th>Monetary loss (T Shs.)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1976</td>
<td>2,624</td>
<td>5,891.1-9,630.1</td>
<td>95,014.70-163,711.70</td>
</tr>
<tr>
<td>1977</td>
<td>1,811</td>
<td>3,857.4-6,646.4</td>
<td>65,569.00-112,988.80</td>
</tr>
<tr>
<td>1978</td>
<td>2,046</td>
<td>4,358.0-7,508.8</td>
<td>74,086.00-127,649.60</td>
</tr>
<tr>
<td>1979</td>
<td>3,225</td>
<td>6,869.2-11,835.7</td>
<td>116,776.40-201,206.90</td>
</tr>
<tr>
<td>1980</td>
<td>2,607</td>
<td>5,552.9-9,567.7</td>
<td>94,399.30-162,650.00</td>
</tr>
</tbody>
</table>

*By conversion one U.S.A. dollar is equivalent to 9.28 Tanzania Shillings.

The calculation of the mean weight of the bovine liver in the market in Iringa was 2.9 (±0.77) kg. The monetary losses resulting from the condemnation of bovine livers infected with fascioliasis are given in Table 4. The losses are enormous and highlight the economic upsets imposed by this disease in the district of Iringa and, perhaps, in those other districts of Tanzania with similar prevalence rates. Monetary losses due to condemnations of bovine livers infected with fascioliasis from other East African countries, are also colossal. In Kenya, for example, a loss of £40,000 per annum was reported (Bitakaramire, 1968).

Nevertheless, all these monetary losses do not include the amount of money spent on either the purchase and application of fasciolicides or on the application of conventional control methods eg. fencing off water swamps, construction of water troughs etc. Also not included under monetary loss in the loss of animals dying from fascioliasis; losses which according to Taylor (1968) can hardly be estimated on a nation wide scale.

Losses due to side effects of liverfluke infestation are perhaps the most difficult to assess in monetary terms. These include retardation of growth lowering of natural resistance against diseases, reduction in milk production etc. In some of the high grade dairy cattle farms in Iringa district, for example, the farmer has to treat the lactating cows at least every six weeks against fascioliasis; failure to do so resulting into a rapid drop in the milk yield (Mahlau, 1981).

Cattle slaughtered at the Iringa abattoir are drawn from various parts of the Iringa district. The fascioliasis cases diagnosed at the abattoir are, therefore, a reflection of the situation of bovine fascioliasis in the district.

**ACKNOWLEDGEMENTS**

This study would have been impossible without the proper documentation of the meat inspection records at the Iringa District Livestock Development Office.

The author is indebted to Dr. A.M. Macha, Director General of the Tanzania Livestock...
Research Organization for his criticisms, ideas
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PATHOGENICITY OF TRYPANOSOMA BRUCEI BRUCEI IN DOGS

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SUMMARY

Clinical signs of T. b. brucei in dogs were similar to those recorded by previous workers. There was normocytic normochromic anaemia accompanied by a leucocytosis that tended to subside. There was a low albumin level with concurrent reduced total protein levels. Amino-transferases (ASAT and ALAT) were elevated in the disease course but they also declined with the deteriorating clinical condition.

INTRODUCTION

The infection of *Trypanosoma brucei brucei* in dogs was first described by Bouffard (1908). Since then, it has been established that the dog is susceptible also to *T. b. rhodesiense*, *T. b. gambiense*, *T. congoense*, *T. evansi* and *T. cruzi*. The dog's susceptibility to all the African trypanosomes places this animal in a suspicious position as a possible reservoir of the infections for other animals. Furthermore, treatment against *T. b. brucei* in dogs is not always successful (Sayer *et al*. 1979). A study of as many aspects of the pathology and pathogenesis of the disease could be of use in trying to establish more systematic means of treating and controlling the infection in dogs. The clinical signs and histopathology have been described in detail (Sayer *et al*. 1979; Mwambu, 1979; Morrison *et al*. 1981a, 1981b).

The aim of this work was to investigate some clinical pathological aspects of *T. b. brucei* infection in dogs by determining and relating the clinical signs to the changes in haematology, total serum protein, globulin, and the serum aminotransferases (ASAT, ALAT).

While studies of the changes in the red blood cells tend to show some or less a similar trend i.e. constant feature of anaemia, as in infected dogs (Sayer *et al*. 1979) there seems to be a lot of variation in leucocytic changes in different animal species suffering from trypanosomiasis (Anosa, 1980). Leucocytic changes in dogs infected with *T. b. brucei* have not been reported.

Literature concerning total serum protein changes in trypanosome infected animals is inconsistent. Decreased protein levels have been reported in cattle and goats (Fiennes *et al*. 1946; Anosa and Isoun, 1976; Tabel, 1978), while an elevation has been reported in sheep (Anosa and Isoun, 1976). However, Clarkson (1968) found no changes in infected sheep. However, Clarkson (1968) found no changes in infected sheep. In man and monkeys, decreased levels of total serum protein and serum albumin have been reported by Jenkins and Robertson (1957a; 1957b). So far, nothing has been found in relation to dogs.

In the dog, the aspartate aminotransferase (ASAT) formerly SGOT is most abundant in the heart muscle, liver, and skeletal muscles, although it is found in almost all other tissues (Cornelius, 1970). The alanine aminotransferase (ALAT) formerly SGPT, is found mostly in liver parenchymal cells. In cases of tissue destruction, these enzymes are released into circulation. Their estimation has been found to be of diagnostic value in judging the extent of tissue injury in various pathological conditions in other animals (Kuttler and Marble, 1958; Boyd, 1962) and in humans (Pryse-Davies and Wilkinson, 1958). Should these enzymes have consistent changes, their estimation could be useful in assessing tissue damage or recovery after therapy during trypanosomiasis infections.

MATERIALS AND METHODS

Animals:

Albino mice were used for maintaining the parasites and for donating infective trypanosomes. Adult local dog breeds were used in the experiments.
Parasite:

*Trypanosoma brucei brucei* ILRAD 273, isolated from a naturally infected Kongoni in Serengeti National Park, Tanzania, in 1971 and propagated in rats was used. It was already adopted to mice and rats. On preliminary testing, it was found to be very pathogenic to dogs.

Infection:

Trypanosomes were separated from mice blood according to Lanham’s method as modified by Staak *et al.* (1976). Each of 8 dogs was intravenously inoculated with $10^4$ parasites, and four dogs were left as uninfected controls. Each animal was examined daily for the presence of parasites by the haematocrit centrifuge (Woo, 1971). Temperatures were taken daily while blood smears for staining with Giemsa, anticoagulated blood for haematology were taken on alternate days and serum samples were taken at the same time from each dog, and stored at $-20^\circ$C until used.

Blood analysis:

Giemsa stained blood smears were used for white blood cell (WBC) differential counting, while the total WBC count was done through an automatic electronic coulter counter (Coulter Electronic’s, Coulter Model ZB Inc. 590). Red cell parameters (PCV, RBC and MCV) were estimated through the same coulter counter, while the Hb was estimated through a haemoglobinometer attached to the main instrument. The MCHC was calculated from the RBC indices.

Total serum protein (T.P.) and albumin were estimated by the Biuret method as modified by Reinhold (1953), and globulin was obtained by the difference between the two.

Aminotransferases:

ASAT and ALAT were estimated using the colorimetric method of Reitman and Frankel (1957). Serum samples for ASAT, ALAT and the proteins, were taken from 5 dogs, that had a very acute disease, and died within 20 days of infection.

RESULTS

All dogs developed trypanosomiasis within 4-10 days post infection. Symptoms consisted of high temperature (Fig. 1), rough, loose hair coats, pale mucous membranes, lethargy, depression, muscular weakness, anorexia and weight loss. Superficial lymph nodes were enlarged but they regressed towards the terminal stages. There was oedema, especially of the head (cheeks, ears, periorbital area), limbs, and external genitalia. In males, there was orchitis, and oedema which subsided in the advanced stages. Conjunctivitis was a feature, with creamy discharge, then corneal opacity and eventually blindness. Animals were recumbent 2-3 days prior to death.

Haematological analysis showed reduced Hb, PCV and RBC counts (Fig. 2, 3, 4). The MCV, MCHC and MCH, were within normal ranges. The stained blood smears showed increased numbers of immature red blood cells. The total WBC counts showed a leucocytosis in the middle course of the disease (Fig. 5). The differential WBC counts indicated that the leucocytosis was due to neutrophilia (Fig. 6) and not lymphocytes (Fig. 7). The fluctuations of the mean monocyte and eosinophil counts did not appear to be related to the disease process neither did they differ from those of the control dogs.

There was a decrease in total serum protein (T.P.) (Fig. 8) and a corresponding decrease in serum albumin but not globulins (Fig. 9).

The serum aminotransferases expressed in Frankel units/litre were elevated during the infection. ASAT was more elevated than the ALAT (Fig. 10). In both cases the levels declined in the critical stages of the disease.
Fig. 1 Mean rectal temperatures in experimental dogs.

Fig. 2 Haemoglobin concentration (g/100ml) in experimental dogs.
Fig. 3 Mean PCV percentages in experimental dogs.

Fig. 4 Mean RBC counts in experimental dogs.
Fig. 5 Total white blood cell (WBC) counts in dogs.

![Graph showing WBC counts over time]

**Key.**
- • Dogs infected with *T. b. brucei*.
- • Non-infected (control) dogs.

Fig. 6 Neutrophil counts in experimental dogs.

![Graph showing neutrophil counts over time]

**Key.**
- • Infected dogs.
- • Non-infected (control) dogs.
Fig. 7 Lymphocyte counts experimental dogs.

![Graph showing lymphocyte counts over days post infection.](image)

**Key:**
- **Infected dogs.**
- **Non-infected (control) dogs.**

---

Fig. 8 Total serum protein (T.P.) in experimental dogs.

![Graph showing serum protein levels over days post infection.](image)

**Key:**
- **Dogs infected with T. b. brucei.**
- **Non-infected (control) dogs.**
Fig. 9 Serum albumin and globulins in experimental dogs.

Fig. 10. Aminotransferases in dogs.
DISCUSSION

The clinical signs observed in these dogs did not differ from those reported by Sayer et al. (1979) and Mwambu (1979). The most likely major cause of the normocytic normochromic anaemia observed was excessive destruction of the red blood cells, as evidenced by increased erythropagocytosis. It had been shown (Sayer et al. 1979) that the half-life of the canine RBC becomes reduced in *T. b. brucei* infections. Woo and Kobayashi (1975) had postulated an immunological cause for the changes in the physiology of the RBC. The total WBC were, however, elevated, but later came down to pre-infection levels during the terminal stages. The occurrence of a leucocytosis in trypanosomiasis, as observed in these dogs was similar to what has been reported in monkeys infected with *T. gambiense* (Smithers and Terry, 1959) although in the latter the condition tended to persist throughout the disease course. A leucopenia has been reported in rabbits infected with *T. brucei*, and in cattle with *T. congolense* and *T. vivax*, (Anosa, 1980). In the dog, leucocytosis and neutrophilia can be due to a multiple of causes viz. physiological emotional upsets, corticosteroids, acute infections, blood loss, neoplasia, necrosis and myelo-proliferative disease (Rich, 1974). The trend of the leucocyte curve does conform only with the possibility of trypanosomiasis. Leucocytic responses are quite common to inflammatory processes in the dog (Rich, 1974); the inflammatory nature of trypanosomiasis could have led to that reaction.

With regard to serum protein, there was no hypoproteinaemia. The decreased T.P. levels observed in these dogs have also been reported in monkeys acutely infected with *T. rhodesiense* (Jenkins and Robertson, 1957b) and in cattle and goats infected with *T. vivax* (Anosa and Isoun, 1976). True hypoproteinaemia is more often reported in chronic infections, and it is associated with increased vascular permeability (Fiennes, 1970).

The rather high globulin levels in the non-infected dogs might be a result of non-specific infections common in the tropics. A similar situation was also found in man where they also tend to have high globulin levels (Turner and Voller, 1966; Houba and Allison, 1966). In the infected dogs, there was a decrease in total albumin that led to lowered T.P. levels, a situation, also found in man and monkeys infected with *T. rhodesiense* (Jenkins and Robertson, 1957a, 1957b). This might be due to the damaged hepatocytes that cannot synthesize adequate albumin. The globulin levels of the infected dogs were almost similar to those of the controls, whereas the T.P. values of the former showed a decline below the controls. This indicates a relative increase of the percentages of the circulating globulins, the fact which has been proved in many other animals (Houba et al. 1969).

The serum aminotransferases (ASAT and ALAT) were elevated although ALAT was not as raised as the ASAT in the middle of the disease course. This could have been due to the limited distribution of ALAT which is mainly in the liver only, while ASAT is found in most of the body tissues. The origin of these enzymes could be the damaged tissue cells, as indeed was suggested by Lippi and Sebastiani (1958) in guinea pigs infected with *T. brucei*. Gray (1963), however, obtained results suggesting that the parasites themselves, (*T. vivax*) could have led to the raised levels more than the damaged tissues of cattle. The latter explanation might be better fitting in the case of the dogs in the present study which were supposed to have maximum tissue damage in the terminal stages and yet they had relatively low transaminase levels. It is therefore more likely that with a reduced body reaction to the trypanosomes the latter proliferated leading to the release of the enzymes. It is, however, worth remembering that RBC also contain appreciable levels of these enzymes; and the disease leads to RBC destruction. We therefore need more studies to correlate the serum enzyme levels during the infection, with the RBC destruction, enzyme content in *T. b. brucei* parasites and with the parasitaemia on a daily basis before we can use the parameter for determination of the extent of tissue damage in dogs.
ACKNOWLEDGEMENTS

The authors are grateful to the technical staff of the Department of Veterinary Pathology and Microbiology, sections of Clinical Pathology and Biochemistry, University of Nairobi, for their excellent assistance in this work. We would also like to thank Mr. C. Kahango for typing this manuscript.

The Senior author was on a DAAD Scholarship during the time when this work was done and is very grateful to them. This work was part of a Ph.D. Thesis presented to the University of Nairobi.

REFERENCE


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THE RELATIONSHIP OF GLOBULE LEUCOCYTES AND SUB-EPITHELIAL MAST CELLS IN HORSES NATURALLY INFECTED WITH STRONGYLUS VULGARIS

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SUMMARY

The occurrence of large numbers of globule leucocytes in the large intestine of horses naturally infected with Strongylus vulgaris is related to the presence of the parasite and also to the sub-epithelial mast cell population. Globule leucocytes occurred mainly in the caecum, the prime site of infection with S. vulgaris. Their role in the immune response of the horse to nematode infection is discussed.

INTRODUCTION

The globule leucocyte is a non-epithelial cell that is found beneath the epithelia in many animals including man and in birds’ (Gregory, 1979). It is a characteristic cell which has a round or oval nucleus and pale cytoplasm containing large acidophilic globules or granules. The number and size of the granules vary greatly and there is some variation in their staining reactions (Takeuchi et al., 1969). The cell is normally found within the epithelium of mucous surface; and increases in number during the intestinal phase of nematode infections (Miller and Jarret 1968, 1971; Kelly and Ogilvie 1972; Breeze et al. 1976; Gregg et al. 1978). The original and function of globule leucocyte has been a subject of controversy. Murray et al. (1968) have shown that the cell is derived from the sub-epithelial mast cell which it resembles histochemically and ultrastructurally. These authors have also demonstrated a transitional cell between globule leucocyte and sub-epithelial mast cell. Whur (1966, 1967) has shown that the cell is associated with immune response to Nippostrongylus brasiliensis in the intestine of rats and it has been suggested that the transformation of mast cell to globule leucocyte might be associated with the effector mechanism which is involved in the transportation of immunoglobulins produced in other cells into the lumen of the gastro-intestinal tract (Jarret, et al. 1967). There is very little information on the relationship of globule leuco-

cyte to the gastrointestinal nematode infection in the horse as found in the literature for rats, sheep and cattle.

This paper reports the relationships of globule leucocyte with the sub-apithelial mast cell population in the large intestine of horses naturally infected with Strongylus vulgaris.

MATERIALS AND METHODS

Tissues were taken post mortem from the caecum, ventral colon, small intestines and mesentery of five Forest Mountain ponies naturally infected with S. vulgaris. Tissues were also taken from similar sites from a 10 day old foal and a near term fetus to serve as worm-free controls. It was not possible to obtain older worm-free animals at the time of sampling. The source of these animals was Potters and Sons Slaughter House at Bishop Sutton near Bristol. The ponies were aged two to four years.

The large intestines were opened and the adult S. vulgaris in the caecum and ventral colon were identified as described by Soulsby (1968) and counted. The anterior mesenteric artery and its main branches from each animal were dissected and the total number of arterial larvae recovered were also counted.

Tissues were fixed in buffered formal saline and embedded in paraffin wax. Sections from each block were cut at 5 μ and stained by Masson’s trichrome method which stains the intracytoplasmatic granules of globule leucocytes deep red, and also with 0.5% Toluidine blue at pH 4 to reveal the deep purple metal-
chromatic granules of the subepithelial mast cells. One hundred consecutive fields were examined from each slide working vertically upwards from the muscular mucosa to the epithelial surface at a magnification of 100 X under oil immersion. The total number of globule leucocytes in the Masson's trichrome stained slides and the total number of mast cells in the toluidine stained slides were counted. Three slides were examined from each area for the different stains in each animal and the average numbers of cells were recorded. Dividing cells or cells that have discharged their contents were not counted. Photomicroscopy was also done. The coefficients of correlation for cells in the caecum and ventral colon were calculated from the data in Table 1 and were presented in Table II as correlation matrix.

RESULTS

The average numbers of globule leucocytes and subepithelial mast cells counted from each area are shown in Table 1. Also shown are the total numbers of adult S. vulgaris and the arterial larvae. The number of globule leucocytes increased markedly in the caecum of the infected ponies compared with other tissues except in the ventral colon of pony one where a large number of the adult worms were found. There was also a parallel increase in the subepithelial mast cell population in the caecum of the infected ponies. The highest numbers of globule leucocytes occurred in the caecum which is the primary site of infection in all the ponies. Table II shows the correlation matrix of globule leucocytes and subepithelial mast cells in the caecum and ventral colon. This table shows that there is a high degree of positive linear correlation (R = 0.9916) between globule leucocytes and mast cells in the caecum (Fig. 11) and a weak non-linear correlation (R = 0.3412) between globule leucocytes and mast cells in the ventral colon (Fig. 11). This seems to support the view that globule leucocytes originate from subepithelial mast cells and that they occur in the primary site of helminth infection which in this case is the caecum.

Table 1: Total Numbers of adult S. vulgaris, arterial larvae, globule leucocytes and mast cells in caecum, and ventral colon of five infected ponies and two worm free foals.

<table>
<thead>
<tr>
<th>No. of adult</th>
<th>Total No. of arterial larvae</th>
<th>Average No. of Globule Leucocytes</th>
<th>Average No. of Sub-epithelial Mast Cells</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Caecum</td>
<td>Ventral Colon</td>
</tr>
<tr>
<td>Pony 1</td>
<td>156</td>
<td>150</td>
<td>2,998</td>
</tr>
<tr>
<td>Pony 2</td>
<td>136</td>
<td>114</td>
<td>1,594</td>
</tr>
<tr>
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<td>198</td>
<td>—</td>
<td>1,737</td>
</tr>
<tr>
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<td>105</td>
<td>21</td>
<td>655</td>
</tr>
<tr>
<td>Pony 5</td>
<td>71</td>
<td>66</td>
<td>1,181</td>
</tr>
<tr>
<td>Control day</td>
<td></td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>old foal</td>
<td></td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Full term</td>
<td></td>
<td>—</td>
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<tr>
<td>fetus</td>
<td></td>
<td>—</td>
<td>277</td>
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</tbody>
</table>

Table 2: Correlation Matrix of globule leucocytes and mast cells in the caecum and ventral colon.

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<td>2</td>
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<td>1</td>
<td></td>
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<td>1</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
The relationship of globule leucocytes and sub-epithelial mast cells in horses and naturally infected with Strongylus vulgaris

HISTOLOGICAL FINDINGS

In the infected horses there was a preponderance of globule leucocytes in the epithelium of the caecum from the mucosal surface to the lamina propria and there were also numerous subepithelial globule leucocytes (Fig. 1 and II). The intraepithelial globule leucocytes were large, oval or round cells with unstained cytoplasm containing large acidophilic intracytoplasmic granules or globules sometimes indenting the nucleus. The globules were stained deep red with Masson's trichrome and showed varying degrees of metachromasia, from light blue or stain (Fig. III). The nuclei were round and mostly eccentrically placed and the chromatic material appeared densely arranged in clumps around the periphery (Fig. 1). Some of the globule leucocytes had ruptured discharging their granules (Fig. 1) while some appeared devoid of granules and some could be seen on either side of the basement membrane (Fig. II).

In the lamina propria and subepithelial locations, the globule leucocytes appeared smaller in size and some were more elongated while some had enlarged nuclei with two nucleoli indicating cells in the process of mitosis (Fig. III). Some similar cells to subepithelial globule leucocytes appeared to contain smaller granules while some have granules of similar size and density to those of intraepithelial globule leucocytes and subepithelial mast cells (Fig. II). These were probably the transitional cells between mast cells and globule leucocytes described by Murray et al (1968). In the mucosa muscularis the globule leucocytes were seen in perivascular positions and the blood and lymphatic vessels appeared congested. A few globule leucocytes were also seen in the serosal surface of the caecum of the infected animals. A few plasma cells were observed alongside the globule leucocytes but appeared smaller, their cytoplasm was stained light red and devoid of any granules (Fig. II).

In the Toluidine blue slides the mast cells were stained deep purple with dark eccentric nuclei and deep violet or purple metachromatic intracytoplasmic granules (Fig. III). They were large oval cells which occurred in large numbers in sub-epithelial locations and were almost absent in the mucosal epithelium. From the staining reactions it appeared that the globule leucocytes and the sub-epithelial mast cells contained an acid mucopolysaccharide as reported by Jarret et al (1967).

In the infected animals the numbers of

Fig. 1.

Fig. 2.

Fig. 3.
globule leucocytes and mast cells increased markedly when compared with the fewer numbers of cells seen in worm-free controls (Table 1). There was also a parallel increase in both globule leucocytes and mast cell populations in the infected ponies. However, the increase was much less in the ventral colon and ileum. There were apparently no globule leucocytes and mast cells in the mesentery of infected and control animals. There were some depressions on the epithelial surface of the infected caecum with some necrotic epithelial cells surrounded by mononuclear cells. Generally, however, there was no evidence of significant pathological change visible by light microscopy.
DISCUSSION

The table and histopathological findings show that there is a marked increase in the number of globule leucocytes in the caecal epithelium as a response to infection with *Strongyulus vulgaris* in the horse. There is also a parallel increase in the number of sub-epithelial mast cells in the infected animals compared with worm-free controls. This suggests that a relationship exists between the globule leucocytes and the sub-epithelial mast cells in the horse in response to intestinal nematode infection. A similar relationship has been reported in the rat (Murray et al., 1968; Miller, 1971) and in the mouse (Ruitenberg and Elgersma, 1979). The increase in the total number of globule leucocytes was more marked in the caecum that in the ventral colon or ileum of the infected ponies. This indicates that globule leucocytes occur mainly at the site of worm infection. Whur (1966) reported a similar observation in sheep infected with *Ostreptasia circumcineta* and in rats infected with *Nippostrongylus brasiliensis*.

Adult and larval stages of *S. vulgaris* were counted and the globule leucocyte numbers were related to the total numbers of *S. vulgaris*. However, it is probable that other strongyles e.g. Trichonema were present in the large intestines of the infected horses as the large intestinal parasite population is invariably a complex mixture of genera and species. These would have contributed to the marked increase in total number of globule leucocytes recorded.

From the staining reactions and the morphology of the cells, it seems probable that the globule leucocytes in the horse originate from the sub-epithelial mast cells. Transitional stages as well as cells in mitosis were observed in the blocks from infected animals. Also globule leucocytes were observed in considerable numbers in the lamina propria and in the sub-mucosa as well as in perivascular positions where mast cells were also seen. Some were also seen across the basement membrane and those globule leucocytes in sub-epithelial locations appeared more elongated than the intraepithelial ones. All these facts seem to suggest that the globule leucocytes in the horse originate from sub-epithelial locations and those seen in the intra-epithelial positions have migrated there. Murray et al. (1968), Miller (1971), Miller and Jarret (1971) and Ruitenberg and Elgersma (1979) have demonstrated that globule leucocytes originate from intestinal mast cells but Dobson (1966a, b), Whur and Johnston (1967) and Whur and Gracei (1967) considered that mast cells and globule leucocytes were unrelated and that globule leucocytes originated from plasma cells or other immunoglobulin producing cells.

The role of globule leucocytes remains a subject of controversy. Whur and Johnston (1967) and Whur and Gracei (1967) postulated that the globule leucocytes contain antibody and that their function is to carry antibody into the intestinal lumen. Dobson (1966b) also concluded that globule leucocytes contain condensations of globulin and Mayrhofer et al. (1976) demonstrated that mast cells and globule leucocytes in rats immune to *N. brasiliensis* contain intracellular concentrations of immunoglobulin E (IgE). Murray et al. (1968) refuted the hypothesis that globule leucocytes belong to the series of immunoglobulin-producing cells but suggested that the transformation of mast cells to globule leucocytes could be associated with the effector mechanism which is involved in the transport of immunoglobulins produced in other cells into the lumen of the gastrointestinal tract as reported by Jarret et al. (1967).

In the present study, based on the staining reactions, both the globule leucocytes and sub-epithelial mast cells contain an acid mucopolysaccharide as reported by Jarret et al. (1967) and Murray et al. (1968). Whatever the role and the contents of globule leucocytes it is apparent from this study that they are involved in the immune reaction of the animal to gastrointestinal nematode infections considering the reports of Dobson (1966b), Whur (1967), Murray et al. (1968), Miller and Jarret (1971), Mayrhofer et al. (1976) and Ruitenberg and Elgersma (1979). However further studies are required to clarify this situation.
ACKNOWLEDGEMENTS

I am sincerely grateful to Dr. (Mrs.) Lucke of Department of Comparative Pathology, Bristol Veterinary School and Mrs. Madeline Fordham of Department of Pathology, Cambridge Veterinary School, for technical assistance and to Mr. A. Jaferies, the University Pathologist, Cambridge Veterinary School, for photomicroscopy and advice in the preparation of the manuscript.

REFERENCES


Received for publication on 4th July, 1983
COWDRIA RUMINANTUM INFECTION IN THE INDIAN SPOTTED DEER (Axis axis): A REPORT OF TWO CASES

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SUMMARY

Two cases of heartwater are described in the Indian spotted deer (Axis axis) kept at the University of Ibadan Zoological Garden. Cowdria ruminantium organisms were demonstrated in crush smears of brain tissue stained with Wright’s stain in both cases. Other lesions present included myocardial degeneration, glomerulonephritis, haemoglobin nephrosis, kupffer cell hyperplasia in the liver and loss of splenic follicular lymphocytes.

INTRODUCTION

Heartwater is a specific disease of cattle, sheep and goats. The causative agent Cowdria ruminantium is an intracellular parasite which is transmitted in Nigeria by the tick Amblyomma variegatum (Ilemobade and Leeflang, 1977 and 1978). The disease is characterized clinically by high fever, nervous manifestations and large amount of fluid in the pericardial sac, death resulting from systemic infection (Smith et al., 1972). Other changes include fall in total protein values, increased alpha globulins and histologically, depletion of lymphocytes of follicles of the spleen and lymph nodes (Ilemobade and Blotkamp, 1978).

Natural and experimental infections have been reported in both local and imported breeds of domestic ruminants in Nigeria (Isoun et al., 1974; Ilemobade, 1977). Attempts at artificial infection of four impala (Aepyceros melampus), three blue wildebeest (Connochaetes taurinus), a buffalo (Syncerus caffer), a kudu (Tragelaphus strepsiceros), a giraffe (Giraffe camelopardalis), and a warthog (Phacochoerus aethiopicus) failed to produce the disease (Grandwell et al. 1976).

The following is a report of two cases that occurred spontaneously in the Indian Spotted deer (Axis axis) at the University of Ibadan Zoological Garden.

CASE HISTORY

Two adults Indian Spotted deers (Axis axis) died at the University Zoological Garden within eleven weeks of each other. The first case exhibited mild nervous signs characterised initially by hyperactivity and terminal recumbency. The second animal was reportedly found dead overnight.

PATHOLOGICAL FINDINGS

Gross lesions were similar in both cases and consisted of diffuse congestion of the nasal turbinates, blood tinged foamy exudate in the trachea, copious straw-coloured hydrothorax and hydropericardium, chicken fat clot in the left ventricle and focal haemorrhages on the ventricular endocardium. The ependyma of the brain was markedly congested and other areas of the brain were mildly congested. In one of the cases, there was foreign material (cellophane) in the rumen and an adult round worm in the small intestine.

Histologically, there was focal myocardial necrosis and calcification of individual myocardial fibres. The kidneys showed interstitial and glomerular mononuclear cell infiltration, diffuse tubular degeneration with tubular inhibition of golden yellow haemosiderin pigment and haemorrhagic foci. There was loss of splenic follicular lymphocytes. Brain vessels showed moderate congestion.

PARASITOLOGY

Crush smears of the brain tissue stained with Wright’s stain in both cases showed Cowdria ruminantium organisms within the blood vessels (Fig. 1).

DISCUSSION

This would appear to be the first spontaneous cases of heartwater diagnosed in the Indian Spotted deer in Nigeria.
Fig. 1.

The nervous signs observed clinically in one deer just before death, and the gross lesions of hydropericardium and hydrothorax as well as the demonstration of the causative agents in the endothelium of blood vessels of the brain of both deers are characteristic of the spontaneous disease in small ruminants (Isoun et al., 1970; Smith et al., 1972; Ilemobade and Leeflang, 1977).

The Indian Spotted deer (Axis axis) is a valuable zoological animal which is imported world-wide from its natural habitat in the forest region of Southern Asia. Care must be taken to prevent the animal from succumbing to prevalent diseases to which it is susceptible in the areas of importation. Our findings indicate that heartwater is one of such diseases; and should form a differential diagnosis in cases of nervous symptoms in these animals when raised in our environment.

REFERENCES


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THE EPIDEMIOLOGY OF RABIES IN KADUNA STATE: RESULTS OF A SURVEY

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*Dr. Beran is a Professor in the Department of Veterinary Microbiology and Preventive Medicine, Iowa State University, Ames, Iowa, U.S.A. He served in Ahmadu Bello University as a Fulbright Professor.

SUMMARY

A study on the epidemiology of animal and human rabies in Kaduna State is reported. The study involved questionnaire surveys of veterinary establishments, personal interviews of veterinarians, physicians, and heads of villages and hamlets scattered over the state as well as examination of available records. Rabies (or rabies-like disease) was found to be more prevalent in cities and large urban areas than in the rural areas, and relatively more prevalent in the south where there are large numbers of dogs than in the north where the dog population is low. The correlation of rabies with the canine population, and the absence of any evidence of rabies in wild animals led to the conclusion that the domestic dog is the major (perhaps the only) reservoir as well as the vector of the virus. The implications of the distribution patterns and ecology of the virus in control strategies are discussed.

INTRODUCTION

Rabies is a major public health problem in Nigeria. Most experts agree that the disease is widespread in the country although reliable information on its incidence and distribution is sparse. Official reporting of rabies in man and animals is often fragmentary and deficient. In rural communities especially, and even in the urban centres, human deaths from rabies may pass unrecognized because of the long and often erratic incubation period; such deaths may not be associated with animal bites, particularly in the absence of expert medical opinion. Reports only occur when patients are attended at hospitals or a unique clustering of cases stimulates further investigation. Under the present state of official disease reporting in both people and animal in Nigeria, perhaps the most reliable means of obtaining information on the distribution and natural history of rabies is for investigators to actively seek existing human or veterinary clinical records, and evidence of human cases recalled by physicians, animal cases recalled by veterinarians, or descriptions of identifiable cases in people or animals by local residents.

Information on the ecology of rabies, the incidence, geographical distribution, reservoir hosts, methods of persistence in the environment and of transmission from one host to another, is needed for proper planning and evaluation of control strategies. This report represents an effort to delimit the extent and distribution of rabies in Kaduna State.

MATERIALS AND METHODS

Questionnaire

A questionnaire was prepared, and in consultation with the Chief Veterinary Officer (CVO), Kaduna State, copies were distributed to all state Divisional Veterinary Officers (DVO) and livestock superintendents in stations not manned by DVOs. The questionnaires were designed to collect available data from the DVOs records over a period between 1975 and 1980. Among the data requested were information on (a) number of canine rabies outbreaks per year, (b) number and species of animals in which rabies was diagnosed, and method of diagnosis, (c) number of dog bites reported, and biting animals, (d) number of animals vaccinated against rabies per year, (e) number of rabies cases in vaccinated animals, and (f) source of vaccines and methods of storage. The completed questionnaires were collected during a subsequent visit to the Veterinary Officers.

Oral Interviews

We also visited each DVO and the CVO and conducted oral discussions with them on their views and personal experience with rabies
disease and control methods. During our visit to each divisional headquarters, we also arranged to interview the physicians and hospital superintendents in charge of the local hospitals. We also arranged to interview as many village or hamlet heads as possible.

All interviewees were conducted by at least three of us. The livestock superintendent or other employee of the divisional veterinary office generally arranged the interview with the village heads, and usually also acted as interpreter. A standardized format was used for all interviews. Questions were prepared ahead of time and each person was presented with essentially the same questions, though the order often varied. In the rural villages, we attempted to estimate the human population, the canine and feline population, the incidence of "mad" dogs or cats, the incidence of animal bites, the incidence of human rabies, the local reaction to and treatment for bites. Human population was estimated as a product of the number of households ("gida je") and the estimated average number of persons per household. The dog population was estimated by using the average number of dogs per household in the area. The village heads were asked for their recollections or incidences of "mad" dogs during the past two-three years, and subsequently asked to describe the behaviour of the mad dogs.

At the hospitals, we attempted to determine the daily or weekly incidence of animal bites reported for treatment, and the number of cases of human rabies encountered in the hospital year. Individual opinions on the problems of persistence and control were also sought.

Pathology Records

Records of rabies diagnosis done between 1971-1973 in the Pathology Department of the Faculty of Veterinary Medicine Ahmadu Bello University, Zaria, were reviewed. Records were incomplete between 1974 and 1978

<table>
<thead>
<tr>
<th>Division</th>
<th>HUMAN</th>
<th>CANINE</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>No. of dog bites per year</td>
</tr>
<tr>
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</tr>
<tr>
<td>Kataina</td>
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</tr>
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<td>Funtua</td>
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<td>3</td>
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</table>

* Records for 1979-1980 only.
*** Recorded vaccine failures in 2 dogs, i.e., Rabies occured in these dogs that were previously vaccinated.
**** Information obtained from the local hospital.
because of breakdown of equipment (such as the fluorescence microscope) and occasional absence of trained personnel.

RESULTS

Questionnaire Survey

The data obtained from the questionnaires are presented in Table 1. The most striking observation is an apparent north-south gradient in the incidence of dog bites, which is also reflected in the incidence of rabies. Towns north of Zaria, such as Funtua, Katsina and Daura reported very few dog bites, and subsequent interviews showed that ownership of dogs in these areas was confined to the non-indigenous population, usually residing in the Government Reservation Areas (GRA). There were few cases of dog bites in people, few outbreaks of rabies, and few animals were vaccinated against rabies.

Kaduna and Zaria reported the highest numbers of dog bites as well as of rabies vaccinations. The other cities reported very few dog bites. We could not compare the absolute incidence of dog bites in the towns surveyed because we lacked information on the completeness of the reports of dog bites, the canine population and even the human population. The available reports showed a rate of dog bites higher in the large cosmopolitan cities than in rural towns, among other reasons, perhaps because the large human populations created more opportunities for canine-human contacts.

One probable explanation for the poverty of records, reflected in the comments of the DVOs, was the lack of a clear and coordinated channel for reporting cases of animal bites or rabies. While some people reported to the police, others reported to hospitals or dispensaries, others reported to veterinarians and an unknown number of victims probably did not report to anyone.

Interviews

The information obtained from the oral interviews is summarized in Table 2. The dog population was negligible in villages around Katsina and Funtua, and consequently there were no recollections of dog bites or rabies. The dog population increased progressively as we moved south, and so did recollections of dog bites and rabies. Villages in the Zonkwa and Kafanchan areas appeared to have the highest density of dogs; most households had at least one dog, and some had up to four.

Canine rabies paralleled the dog populations. In the north of the state, no cases of rabies, human or canine, were reported. In the south, on the other hand, we frequently encountered stories of "mad" dogs, but surprisingly there were fewer cases of human exposures to disease. The explanation may lie in the

Table 2: Summary of Information Obtained in Oral Interviews of Village and Hamlet Chiefs, Kaduna State

<table>
<thead>
<tr>
<th>Division/Village</th>
<th>Estimated No of households</th>
<th>Estimated human population</th>
<th>Estimated dog population</th>
<th>No. of Rabies Cases per year in</th>
<th>Human Rabies cases in</th>
<th>Date of Latest human death</th>
</tr>
</thead>
<tbody>
<tr>
<td>Katsina</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Kamb Araw</td>
<td>1,000</td>
<td>10,000</td>
<td>2</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Don Dakworo</td>
<td>330</td>
<td>3,000</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Funtua</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maiganji</td>
<td>1,709</td>
<td>10,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Yarbatbi</td>
<td>241</td>
<td>661</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Zaria</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soba</td>
<td>10,000</td>
<td>7,963</td>
<td>600</td>
<td>0</td>
<td>0</td>
<td>Several 1972-73, 1977-78, 1953-80</td>
</tr>
<tr>
<td>Tukur Tukur</td>
<td></td>
<td></td>
<td>300</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zonkwa</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Samaru Katan</td>
<td>1,200</td>
<td>12,000</td>
<td>2,000</td>
<td>10</td>
<td>Many 2</td>
<td>1977</td>
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<tr>
<td>Fadan Sofo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Jankasa</td>
<td>567</td>
<td>8,000</td>
<td>500</td>
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<td>Jaakasa Hamlet</td>
<td>35</td>
<td>300</td>
<td>100</td>
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<tr>
<td>Fadan Kofe</td>
<td>306</td>
<td>3,000</td>
<td>600</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Kafanchan</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fori</td>
<td>120</td>
<td>900</td>
<td>60</td>
<td>1</td>
<td>1</td>
<td>1965</td>
</tr>
<tr>
<td>Fodin Kagoma</td>
<td>2,372</td>
<td>20,000</td>
<td>1,000</td>
<td>3</td>
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</tr>
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</table>
practice of villagers in the rural communities of relentlessly chasing down and destroying all dogs showing aberrant behaviour such as biting other dogs or people. Such practices may have helped reduce the incidence of human (and further canine) rabies. Nevertheless, there was still a considerable number of human deaths that were associated with dog bites. At St. Louis Hospital, Zonkwa, we learned of three deaths within last year in which the clinical diagnosis was rabies. At the other hospitals, inadequate records and recent personnel changes reduced availability of information, but there were still lingering stories of death associated with dog bites.

In the rural areas, canine rabies never seemed to occur in severe or explosive epidemics. The disease appeared to exist as a low level, smouldering, or perhaps vanishing infection which would reappear in the form of an occasional ‘mad’ dog. There were no widespread epizootics. The rural set-up allowed for easy recognition of stray dogs since people tended to know their neighbours’ animals rather readily.

In contrast, canine rabies occurred as epidemics in the cities. Periods of relative calm and low activity were followed by periods of widespread, severe epizootics. Public health and veterinary authorities usually reacted to epidemics with such measures as stray dog control and massive vaccination. Such vaccination campaigns and stray dog controls, when not continued during the interepidemic periods, allowed a gradual accumulation of susceptible stray dogs, hence preparing a fertile soil for the next epizootic seed.

Perhaps bitten by suspicious dogs were subjected to a variety of traditional treatments. In most cases the wound was cleaned and covered with hair from the biting animals. Occasionally bite victims were asked to drink portions which sometimes included liver, spleen or washings of hair from the offending animal. In other cases the victim was regarded as safe from rabies if the biting dog accepted food. Currently, however, bite victims tend to seek medical treatment in dispensaries and hospitals.

Pathology Records

Laboratory examinations were done on the brains of 59 dogs between 1971-1973; 32 brains (54%) were positive by one or more tests (Table 3). Eighteen of the positive cases (58%) were owned dogs while 13 (42%) were stray dogs. Approximately half of the cases in which clinical signs were recorded showed the furious form, and half showed the dumb form of rabies. Rabies was also diagnosed in one cat, one horse, 3 cows and 3 people. The three methods of diagnosis agreed quite closely although the mouse inoculation test was not used as consistently as the others, probably because of lack of infant mice. There were only two cases positive by mice inoculation test but negative by both FAT and the Seller’s stain (negri bodies).

Table 3: Summary of Rabies Diagnosis, Faculty of Veterinary Medicine, A.B.U. Zaria

<table>
<thead>
<tr>
<th>Year</th>
<th>SPP Canine</th>
<th>Total Test</th>
<th>Positive (%)</th>
<th>All Tests</th>
<th>*</th>
<th>+</th>
<th>FAT</th>
<th>+</th>
<th>MI</th>
<th>Owned</th>
<th>Stray</th>
<th>Furious</th>
<th>Dumb</th>
<th>Human Exposure</th>
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<tr>
<td>1971</td>
<td>6</td>
<td>10</td>
<td>6</td>
<td>2</td>
<td>6</td>
<td>6</td>
<td>2</td>
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<td>1972</td>
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<td>25</td>
<td>9</td>
<td>15</td>
<td>16</td>
<td>12</td>
<td>11</td>
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<td>5</td>
<td>4</td>
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<tr>
<td>1973</td>
<td>8</td>
<td>24</td>
<td>2</td>
<td>6</td>
<td>8</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>5</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>59</td>
<td>13</td>
<td>27</td>
<td>30</td>
<td>18</td>
<td>13</td>
<td>9</td>
<td>8</td>
<td>12</td>
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<td></td>
<td>20.3</td>
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<tr>
<td>%</td>
<td>54</td>
<td>100</td>
<td>40.6</td>
<td>45.7</td>
<td>50.8</td>
<td>30.5</td>
<td>13</td>
<td>9</td>
<td>8</td>
<td>12</td>
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</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>SPP Canine</th>
<th>Total Test</th>
<th>Positive (%)</th>
<th>All Tests</th>
<th>*</th>
<th>+</th>
<th>FAT</th>
<th>+</th>
<th>MI</th>
<th>Owned</th>
<th>Stray</th>
<th>Furious</th>
<th>Dumb</th>
<th>Human Exposure</th>
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<tr>
<td>1971-72</td>
<td>Feline</td>
<td>4</td>
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<td>1</td>
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<tr>
<td></td>
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<td>0</td>
<td>0</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Equine</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>—</td>
<td>1</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Bovine</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>—</td>
<td>2</td>
<td>1</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Human</td>
<td>3</td>
<td>3**</td>
<td>—</td>
<td>ND</td>
<td>2</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

* — Positive to one or more tests
ND — Not done
* — from Kano State Government Farm
** — all dead showing signs of rabies
FAT — Fluorescent Antibody Test
MI — Mouse inoculation Test
Fig. 1 Map Showing Kaduna State and Area Surveyed.
DISCUSSION

Attempts to evaluate the magnitude and public health importance of rabies in Nigeria have been difficult because of the scarcity of reliable information on the incidence, distribution, and natural history of rabies. Official reporting of the disease is very deficient; where reports exist, they are often fragmentary, and tend to cover the larger urban centers where hospitals, dispensaries or veterinary establishment exist. The rural areas where there are large numbers of domestic and wild animals which are potential reservoirs and vectors of the virus have virtually been ignored in official reports. Nuru (1973) reviewed the laboratory records of Kano State and reported 4 human deaths and 114 cases of canine rabies during a ten year period (1963-1973). Ezeokoli and Schnurrenberger (1977) in a survey of East Central State reported 44 human deaths and 75 canine deaths during one year period (1973-1974).

Among the conclusions reached in the present duties are that (1) rabies is maintained in a continuum of sporadic cases and epizootics in the state; it is more prevalent in cities and large urban communities than in the rural areas. In the cities, large urban areas and densely populated rural areas, the disease in dogs occurs as epizootics, that is, periods of local disease activity are followed by periods of local quiescence. In sparsely populated rural areas, however, rabies tended to disappear, possibly to be reintroduced with no obvious cyclic patterns. (2) Rabies is more prevalent in the southern parts of the state than in the north, the differences in the prevalence appearing to be directly related to the density differences in the dog population. (3) The domestic dog appears to be the major (perhaps the only) reservoir host as well as the vector of the virus. There is no evidence of involvement of wild animals in the maintenance or transmission of the virus.

The differences in the epidemiologic patterns of disease between the urban and rural areas are interesting in as much as they illustrate how social behaviour can modify the natural history of an epidemic disease. In rural areas, community effort is applied towards efficient destruction of any dog that displays unusual or abnormal behaviour. Stray dogs are readily identified in the rural setup; usually everyone knows his/her neighbours' dogs by sight, hence, unidentified animals are easily recognized and, if necessary, destroyed, drastically reducing the efficiency of the transmission cycle. That is, a rabid dog is often limited to infecting none or only one or two susceptible animals before being destroyed. Such intervillage contact rate may be sufficient to allow rabies transmission to persist in the absence of an effective vaccination program but at a very low rate over a cluster of villages (Bacon and McDonald, 1980). The virus will persist because of the few contacts the rabid dogs make before being destroyed, and because some dogs exhibit signs of dumb rabies which are not readily identified by the layman.

The urban areas lack the community wide systematic control of stray dogs and dogs showing abnormal behaviour. The heterogeneous and cosmopolitan nature of the urban population proclaims the type of social control of stray or abberantly behaving animal that is seen in rural areas. Here rabies outbreaks occur as epizootics whenever there is a build-up in the unvaccinated dog population. Outbreaks elicit ‘reactive’ control measures such as mass vaccinations and destruction of stray dogs. As a result, there is drastic reduction in the susceptible populations; the current epizootics are abated and a period of relative calm ensues until the susceptible dog population increases sufficiently to support another epidemic.

There is very little evidence that wild animals are involved in the maintenance and transmission of rabies. The ground squirrel and the shrew have been suggested as possible reservoirs and vectors of rabies (Nuru, 1973) and in some parts of Nigeria bites of these animals are regarded with some apprehension. In the present survey, however, we found no evidence to suggest that people associated these animals with rabies. Even in a few places where these animals were feared, the fear
was attributed to the severity of the bite or the transmission of other diseases rather than rabies. The shrew, however, has been implicated in the transmission of one of the newly characterized rabies related viruses (Lyssavirus), the Mokola virus (Shope, R.E., Murphy, F.A., Harrison, A.K., Causey, D.R., Kemp, G.E., Simpson, D.I.H. and Moore, D.H., 1970). The existence of such rabies related viruses may be of significant importance in Nigeria, and efforts are underway to identify the extent of their involvement in the canine population.

The patterns of rabies described above have important implications for the selection of control strategies. The apparent limited involvement of wildlife in the natural history of rabies in the state would indicate that control measures directed at the canine population alone may be sufficient to break the epidemiologic chain. In rural areas where an efficient stray dog control system already exists, the control strategy calls for the institution of regular vaccination programs. It has been estimated that vaccination of 80% of the susceptible population would reduce the contact rate between entering rabid animals and remaining susceptible animals below the threshold required for a rabies outbreak (Beran, 1971). If such areas are protected from reintroduction by natural barriers which prevent entry of rabid animals or by being surrounded by rabies free areas, rabies may remain absent. In cities, urbanized areas or in densely populated rural areas unprotected from reintroduction of rabies, constant prevention of buildup of susceptible dog populations by regular vaccination and removal of unvaccinated dogs must be maintained to control the disease.

An interesting aspect of this study concerns the patterns of dog ownership in the state. As noted previously, more dogs are owned in the south of the state, which is predominantly Christian, than in the predominantly Moslem north. At first it appeared that religious inclination was the most important factor in determining who owns dogs. Further inquiry, however, indicated that though Moslems tended not to own dogs, this tendency was more of cultural and superstitious origin than a result of religious doctrine. The most important factor in dog ownership appeared to be utilitarian; hunters, cattle rearsers and people in communities where protection from prowlers was considered necessary tended to own dogs regardless of their religion. There were fewer dogs in small rural communities where the close knit societies had little need for crime protection, except in certain parts of the state where the dog was also used for food. In such areas, large numbers of dogs were reared, most likely, for food.

The sources of our information also deserve some comment. We relied heavily on oral interviews and the memories of the village or hamlet heads. Usually these were the older members of the society, and we were impressed by the clarity of their recollections and by the remarkable accuracy of their description of the clinical signs of rabies in people and animals. Perhaps the frightful nature of the disease was responsible for such indelible impressions. We are convinced that in the absence of an accurate and comprehensive disease reporting system, surveys such as this, even when they rely on memory, are valid methods for obtaining necessary epidemiologic information, particularly for rabies and perhaps for other disease conditions that have clear-cut, distinguishing characteristics.

REFERENCES


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HEPATOCELLULAR CARCINOMA IN A SOW

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*Department of Veterinary Pathology, University of Ibadan, Ibadan, Nigeria.

SUMMARY

A case of hepatocellular carcinoma in a large White sow is presented. The animal could not be rebred, gradually lost weight and died terminally or present persistent pyrexia. The main gross pathology was a hepatomegaly of 20 kilograms weight which, microscopically was characterized by fibrous lobulation, hepatocellular carcinoma, necrosis and vacuolar degeneration.

INTRODUCTION

Hepatocellular carcinoma (hepatoma, liver cell carcinoma) is a neoplastic condition of hepatocytes which though generally rare, has been reported in cattle, sheep, dogs and swine (Moulton, 1978). In Nigeria, the incidence of this tumour in the domestic animal species is not known, yet one of the major predisposing factors is a ration containing aflatoxin (Barnes, 1970) such as is often available to intensely reared Nigerian Livestock and Poultry fed mouldy groundnut cake or maize meals.

The purpose of this communication is to report a case of malignant hepatoma which occurred in an exotic herd of Large White pigs born and reared in Vom.

CASE HISTORY

An adult, Large Sow with a recent history of anoestrus began to loose weight. A few days before it died and the animal developed a temperature of 43.3°C which did not respond to both antibiotic and cold water therapy.

PATHOLOGY

Grossly, there was marked hepatomegaly and the liver weighed 20 kg. One lobe had a big tumour mass in its substance (Fig. 1) and all lobes contained varying sizes of tumour nodules (Fig. 2). The lungs were bilaterally congested. The trachea bronchi and bronchioles were filled with greywhite frothy exudate. The jejunum and ileum had patchy areas of mucosal reddening, with ulcerations and extensive haemorrhages. There were enlarged and one showed areas of infarcts. The ovaries were cystic. There were ecchymotic haemorrhages on the pericardium and endocardium.

The histopathological lesions in the liver included marked fibrous lobulation and degenerating, hyperplastic or neoplastic hepatocytes. The degenerating cells were atrophic or vacuolated with occasional areas of frank necrosis. The transformed cells were hyperchromatic and arranged in cords or islets separated by clefts (Fig. 3). The histopathological changes in the other tissues examined include invasion of the mesenteric lymph

Fig. 1.
nodes by neoplastic hepatocytes, moderate pulmonary oedema, haemorrhagic enteritis, necrotising edometritis and chronic glomerulonephritis.

**BACTERIOLOGY**

Bacteriological examination of lesions yielded human *Escherichia coli* type 3 from intestinal contents and *Corynebacterium pyogenes* from necrotic uterine tissue.

**DISCUSSION**

The present case is the first recorded instance of hepatocellular carcinoma in the twenty-four year history of pig raising in Vom. This primary liver cancer has been associated with ingestion of aflatoxin from mouldy groundnut cake or maize meals (Carnaghan and Crawford, 1964; Barnes 1970).

The histopathological lesions described here are consistent with earlier reports on pigs.
under experimental groundnut poisoning (Loosmore and Harding 1961; Harding, Done, Lewis and Allcroft 1963), and in response to both acute and chronic aflatoxicosis (Harding et al. 1963; Cysewski et al. 1968; Shalkopa and Ambrecht 1974). Recently, Oduye et al. (1983) have reported liver fibrosis in cases of suspected aflatoxin poisoning in pigs in Nigeria.

The standard pig ration used in Vom contains 20-30 per cent groundnut cake. In the past 2 years however, the percentage of groundnut cake in the rations has been elevated sometimes up to 80 per cent due to inadequate supply of maize. In this situation, the animal is likely to ingest a substantial amount of aflatoxin since Nigerian groundnut crops apparently contain this mould toxin even at harvest (Macdonald and Harkness 1967).

Thus the hypothesis that aflatoxin ingestion from mouldy feeds might have caused or predisposed to the tumour in the present communication appears worthy of further investigation. In this regard, many cases of 'enlarged liver' in old swine have been reported on the Vom pig farm which were disposed of before proper pathological examinations could be carried out of them.

The repeat breeding reported in this case was most likely related to the cystic state of the ovaries. The onset of persistent pyrexia probably reflected the state of superimposed bacterial infections. Additionally, the hepatocellular carcinoma may have contributed to the persistence of the pyrexia despite antibiotic and symptomatic therapy since different kinds of neoplasm including those invo-

living the liver can cause persistent fever (Jawetz et al. 1974).

ACKNOWLEDGEMENTS

We wish to thank Dr. A.G. Lamorde, the Director of National Veterinary Research Institute, Vom for permission to publish. We also thank Messrs. A. Odeyemi, K. Adeleye and A.U. Usoro for technical assistance.

REFERENCES


Received for publication on 6th June, 1983
HAEMATOLOGICAL FINDINGS AND SERUM ENZYME ACTIVITIES IN CATTLE EXPERIMENTALLY INFECTED WITH BOVINE PETECHIAL FEVER

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Faculty of Veterinary Medicine, University of Nairobi, P.O. Box 29053, Kabete, Kenya

SUMMARY

Haematology and serum biochemical examinations were carried out on twenty bull calves experimentally infected with Bovine petechial fever. There was a marked decrease in the packed cell volume, red blood cell counts and haemoglobin concentration during the course of illness while the activity of aspartate aminotransferase and alkaline phosphatase showed marked elevations of these enzymes. The haematological and enzymatic changes, were most noticeable during the post-petechial phase of the disease syndrome. The changes were also more pronounced in animals which subsequently died from the experimental disease.

INTRODUCTION

Bovine Petechial Fever is a rickettsial disease of cattle in which the causative agents invade and multiply in circulating phagocytic cells, fixed macrophages and capillary endothelial cells, leading to peripheral vasculitis and haemorrhages (Haig and Danskim, 1962; Kiptoon et al., 1977). The clinical disease syndrome was well documented by Piercy (1953) and postmortem findings have been described by Plowright (1962). The haemorrhagic syndrome leads to the depression of both the red and white cells but there are no reported findings on the activities of the serum enzymes during the disease course.

Elevation in the serum levels of aspartate aminotransferase, AST (formerly glutamic oxaloacetic transaminase, SGOT) activities have been reported in various disease conditions where tissue necrosis has been involved (Henson et al., 1965; Cardinet, 1971; Nagode et al., 1966). Serum enzyme changes occurring in blood parasitic infections have also been reported by other workers (Malherbe, 1956; Munyuca et al., 1979). There are no reported investigations on serum enzyme activity in bovine petechial fever in ruminants. Normal serum AST values in cattle have been presented by Cornelius et al. (1959) and Cornelius and Kaneko (1960) while normal values for Alkaline phosphatase (ALK) have been presented by Varley et al. (1980).

The purpose of this communication is to report the findings of an investigation into the serum protein, haemoglobin and serum enzyme activities in bull calves experimentally infected with bovine petechial fever (BPF, Ondiri Disease).

MATERIALS AND METHODS

Experimental Animals

Twenty high grade (Guernsey, Friesian and Ayrshire) bull calves between 9 and 15 months old were obtained from the Uthiru area of Kabete where ondiri disease has not been recorded for more than ten years. The animals were housed in pens at the animal compound of the Faculty of Veterinary Medicine, and fed grass and lucerne hay and water provided ad libitum. They were clinically examined for two weeks and treated for external and internal parasites. Blood for haematology and serum biochemistry were obtained for baseline values for a period of five days before inoculation was carried out. Only those animals which proved clinically sound were used for the bovine petechial fever inoculation.

The aetiological agent

The rickettsial agent was initially obtained in whole blood of natural field cases of BPF reported from Naivasha district of Kenya. Routine screening of these blood samples was carried out to check for the presence of intercurrent blood parasites before the sample blood was administered to the experimental animals. Infected whole blood (20-50 ml) was given intravenously to the experimental calves. Each calf was then subjected to daily clinical examination and blood collected for
serum biochemistry and slide screening for the rickettsial agents were carried out.

**Determination of the Haematological parameters.**

Routine haematological examinations were done to determine the packed cell volume (PCV), haemoglobin concentration (Hb), red (Rbc) and White (Wbc) blood cell counts and the total serum protein (TP). The PCV was done using the microhaematocrit method as described by Schalm *et al.* (1975), using unheparinized capillary tubes (75 x 1.3 mm, Arthur H. Thomas, Philadelphia) and the microhaematocrit centrifuge (Measuring and Scientific Equipment, MSE, Sussex, England). The tubes were spun in the centrifuge for 15 min. at 3000 g and the value of the PCV read off on MSE microhaematocrit reader. Determination of the TP was done using a refractometer (ATAGO, JAPAN). A single drop of serum from the Wintrobe microhaematocrit tube was placed on the prism of the refractometer and viewed through the eyepiece of the electrical illuminator. The total protein value was obtained directly from the scales and recorded as grams per 100 ml of blood sample. The Hb value was determined by the cyanmethaemoglobin method using a Coulter haemoglobinometer (Coulter Electronics Inc., Hialeah, FL). The readings obtained were recorded as gm/100 ml of blood. Red and white blood cells were enumerated according to a standard method using the Coulter electronic counter (Coulter Electronic Inc., Hialeah, FL).

**Determination of Serum enzyme activities**

The aspartate aminotransferase (AST) activity was determined following the method of Reitman and Frankel (1957) and using the DADE-SGOT reagent (DADE Diagnostic Inc., Miami). The values were read from an Eppendorf photometer using a mercury 546 nm filter and values obtained were expressed in Sigma-Frankel (SF) units per ml. The alkaline phosphatase (ALK) measurements were done following the method of Kind and King (1954) and the values obtained from an Eppendorf photometer readings were expressed in King-Armstrong units (K.A.) per 100 ml of serum.

**RESULTS**

**Clinical Syndrome**

Fourteen experimental animals developed the typical "Ondiri disease" syndrome with fever and petechiation of the visible mucous membranes, while two others only showed a transient temperature rise for two days and recovered. The remaining four animals did not show any clinical reaction after the inoculation. The incubation period varied between five and nine days and the disease course lasted four to eleven days with the animal either progressing to death or slow recovery. The first clinical sign seen was pyrexia, with temperatures between 39.5 and 41°C, which preceded the appearance of petechiae by one or two days. With the appearance of petechial haemorrhages the animals became visibly sick and anorexic which was apparent by the fourth day of sickness (days 8 to 11 after infection). Some severely anaemic animals became weak, recumbent and lethargic prior to death. Six of the experimental animals died between days 10 and 13 during this period of lethargy, anaemia and slow protein content of the blood.

**Haematological changes**

The haematological parameters showed noticeable changes by the second day following the rise of temperature (above 39.5°C) and the appearance of petechiae. With the appearance and progression of petechiae, there was a gradual drop in the PCV, Rbc and Hb. The decrease in the haematological parameters was progressive and more marked in the fatal cases of the experimental disease. The changes in the PCV, Rbc, Hb and TP during the development of the haemorrhagic fever in the six fatal cases are presented in Table 1.

The non-fatal cases of the disease showed similar clinical pattern to the fatal ones, except that their haematological parameters did not show very low levels as in the fatal cases. The recovery in the non-fatal cases was apparent by day 12 to 15 when the drop in their haematological values appeared to stabilise and begin to show a reversal to normal values. Though
Table I: Haematological findings in six animals which were experimentally infected and subsequently died of BPF.

<table>
<thead>
<tr>
<th>Day</th>
<th>Temp. (°C)</th>
<th>PCV</th>
<th>TP</th>
<th>RBC</th>
<th>Hb</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>s.d.</td>
<td>s.d.</td>
<td>s.d.</td>
<td>s.d.</td>
</tr>
<tr>
<td>0*</td>
<td>38.5</td>
<td>31.5 ± 2.8</td>
<td>7.8 ± 0.5</td>
<td>8.1 ± 1.0</td>
<td>10.6 ± 1.2</td>
</tr>
<tr>
<td>1</td>
<td>38.6</td>
<td>31.5 ± 3.0</td>
<td>7.4 ± 0.4</td>
<td>7.8 ± 1.2</td>
<td>10.7 ± 1.5</td>
</tr>
<tr>
<td>2</td>
<td>38.5</td>
<td>30.6 ± 2.5</td>
<td>6.9 ± 0.3</td>
<td>8.0 ± 0.9</td>
<td>10.8 ± 2.2</td>
</tr>
<tr>
<td>3</td>
<td>39.7</td>
<td>31.1 ± 4.1</td>
<td>6.7 ± 0.4</td>
<td>7.2 ± 1.0</td>
<td>10.3 ± 1.7</td>
</tr>
<tr>
<td>4</td>
<td>40.0</td>
<td>29.8 ± 3.5</td>
<td>6.5 ± 0.5</td>
<td>7.2 ± 1.0</td>
<td>9.8 ± 2.1</td>
</tr>
<tr>
<td>5</td>
<td>40.3</td>
<td>29.0 ± 2.8</td>
<td>6.8 ± 0.9</td>
<td>6.9 ± 1.1</td>
<td>9.8 ± 2.4</td>
</tr>
<tr>
<td>6</td>
<td>41.8</td>
<td>26.5 ± 0.8</td>
<td>5.6 ± 1.8</td>
<td>5.6 ± 1.8</td>
<td>7.6 ± 1.5</td>
</tr>
<tr>
<td>7</td>
<td>41.3</td>
<td>24.3 ± 4.3</td>
<td>4.9 ± 0.6</td>
<td>5.1 ± 1.2</td>
<td>7.1 ± 1.6</td>
</tr>
<tr>
<td>8</td>
<td>40.5</td>
<td>21.5 ± 4.1</td>
<td>4.6 ± 0.6</td>
<td>4.6 ± 0.7</td>
<td>5.5 ± 1.3</td>
</tr>
<tr>
<td>9</td>
<td>39.8</td>
<td>19.6 ± 3.7</td>
<td>4.2 ± 0.9</td>
<td>4.4 ± 1.2</td>
<td>4.6 ± 0.9</td>
</tr>
<tr>
<td>10</td>
<td>39.5</td>
<td>17.2 ± 3.3</td>
<td>4.4 ± 1.1</td>
<td>4.1 ± 0.9</td>
<td>4.2 ± 0.9</td>
</tr>
<tr>
<td>11</td>
<td>38.4</td>
<td>16.5 ± 3.9</td>
<td>3.6 ± 0.5</td>
<td>3.4 ± 1.1</td>
<td>3.3 ± 0.5</td>
</tr>
<tr>
<td>12</td>
<td>38.6</td>
<td>14.5 ± 3.5</td>
<td>3.1 ± 0.7</td>
<td>2.9 ± 1.2</td>
<td>3.0 ± 0.3</td>
</tr>
</tbody>
</table>

* — Average for 5 days before infection
PCV — Packed cell volume
TP — Total protein content
RBC — Red blood cell count
Hb — Haemoglobin concentration
s.d. — Standard deviation

all the parameters showed a slow reversal, the protein content took three to five days more to show a significant reversal towards normal values. The haematological changes observed in the non-fatal cases of the disease are presented in Table II.

Serum biochemical findings

Data concerning the AST and AK activities in the twenty bull calves infected with bovine petechial fever are presented in Table III.

They are given in the form of mean and range values. The rise in the activity of the AST was sudden and followed immediately after the rise of the body temperature. High levels of AST persisted for all of the febrile phase of the disease. The levels of the ALK on the other hand rose more gradually following the development of fever. Their values reached a peak between days 12 and 14 following the inoculation. This period is usually characterized by anaemia and the disappearance of other clinical signs. All the fatal cases died when the levels of the two enzymes were high while the recovering ones showed a gradual pattern to normal values after the disappearance of the petechiae.

DISCUSSION

Research on Bovine Petechial Fever has shown that the rickettsial agent invaded endothelial cells and other cells of the reticuloendothelial (Plowright, 1962; Kiptoon et al., 1977). There is agreement throughout the literature that the haemorrhagic syndrome in BPF is followed by a depression of both the white and red blood cell counts. Information on blood proteins and the activity of serum enzymes has, however, not been documented. Plowright (1962) demonstrated that liver haemorrhages in BPF induced severe degeneration of the parenchymal and sinusoidal cells which would greatly interfere with organ function. The hepatocellular degeneration would further be complicated by tissue hypoxia due to the anaemia which would contribute to more hepatic dysfunction. This would therefore explain the drop in protein content as resulting from interference in protein synthesis. It has also been demonstrated that the liver
Table II: The mean (± s.d.) haematological values in ten non-fatal cases of cattle experimentally infected with BPF

<table>
<thead>
<tr>
<th>Temp (°C)</th>
<th>PCV</th>
<th>s.d.</th>
<th>TP</th>
<th>s.d.</th>
<th>RBC</th>
<th>s.d.</th>
<th>Hb</th>
<th>s.d.</th>
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<td>8.5 ± 0.6</td>
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<td>38.2</td>
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<td>9.1 ± 0.6</td>
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<td>10.2 ± 2.1</td>
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<td></td>
</tr>
<tr>
<td>2</td>
<td>38.6</td>
<td>31.0 ± 1.8</td>
<td>7.6 ± 0.3</td>
<td>8.9 ± 1.5</td>
<td>10.2 ± 1.4</td>
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</tr>
<tr>
<td>3</td>
<td>38.5</td>
<td>32.8 ± 2.5</td>
<td>7.8 ± 1.4</td>
<td>8.6 ± 0.9</td>
<td>10.6 ± 1.5</td>
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<tr>
<td>4</td>
<td>38.8</td>
<td>29.8 ± 1.6</td>
<td>7.2 ± 2.3</td>
<td>7.3 ± 1.1</td>
<td>10.2 ± 0.8</td>
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<tr>
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<td>39.5</td>
<td>27.8 ± 1.9</td>
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<td>9.8 ± 1.4</td>
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<tr>
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<td>40.7</td>
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<td>6.2 ± 1.1</td>
<td>5.4 ± 1.2</td>
<td>8.5 ± 1.9</td>
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<td>41.0</td>
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<tr>
<td>12</td>
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<td>4.5 ± 0.7</td>
<td>3.8 ± 1.1</td>
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<tr>
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<td>4.8 ± 1.0</td>
<td>4.0 ± 1.4</td>
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<tr>
<td>14</td>
<td>38.2</td>
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<td>3.7 ± 1.6</td>
<td>5.5 ± 1.6</td>
<td>5.0 ± 1.4</td>
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<tr>
<td>15</td>
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<td>22.3 ± 3.8</td>
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<td>4.9 ± 1.2</td>
<td>5.8 ± 1.3</td>
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<tr>
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<td>3.9 ± 1.2</td>
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<td>7.4 ± 2.3</td>
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<tr>
<td>17</td>
<td>39.0</td>
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<td>4.3 ± 1.1</td>
<td>5.9 ± 1.7</td>
<td>7.7 ± 1.8</td>
<td></td>
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<tr>
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<tr>
<td>19</td>
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<td>26.0 ± 2.6</td>
<td>5.8 ± 1.2</td>
<td>6.0 ± 1.0</td>
<td>7.8 ± 0.4</td>
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<td></td>
</tr>
<tr>
<td>20</td>
<td>38.5</td>
<td>27.0 ± 1.3</td>
<td>6.4 ± 0.7</td>
<td>6.3 ± 1.2</td>
<td>7.9 ± 1.5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* — Average for 5 days before infection
PCV — Packed cell volume
TP — Total protein content
RBC — Red blood cell count
Hb — Haemoglobin concentration
s.d. — Standard deviation

of the sick BPF animal has a poor (Bromsulphthalein) dye clearance performance which would confirm the interference in its other metabolic and physiological functions (Kiptoon et al., 1977).

Serum enzymes are intracellular tissue components of the animal body which escape into the serum in abnormally high concentration when cells are damaged or where there is alteration in their membrane permeability (Cornelius and Kaneko, 1960). In the bovine the enzyme AST is distributed widely in different cells such as the liver, intestines, heart muscle and kidneys. The rickettsial agents of BPF have been demonstrated to effect the various cells of these organs causing degeneration, petechiation and necrosis (Mugera and Kiptoon, 1978). The organism is an intracellular pathogen of granulocytes, capillary endothelial cells and other phagocytic cells. In the present study, therefore, the increase in AST activities could be attributed to the damage that the rickettsial agents have inflicted on the animal’s tissues.

Increase in the activity of Alkaline phosphatase to levels of 20-30 KA units occurs in bone diseases and liver diseases (Varley et al., 1980). Elevated values in BPF could be attributed to hepatocellular degeneration and necrosis due to the loading of the acinar and sinusoidal cells by the rickettsial agents and the impaired function of the liver.

It should be noted that in the late stages of BPF the main clinical picture is one of severe anaemia after the haemorrhagic syndrome. It is usually very difficult to demonstrate the rickettsial agents in cells of a blood smear during this anaemic phase (Haig and Danskin, 1962). The investigation of serum protein levens and serum enzyme activities may aid in the diagnosis of the disease.
Haematological findings and serum enzyme activities in cattle experimentally infected with bovine petechial fever

Table III. The mean values of Serum Aspartate aminotransferase and Alkaline phosphatase activities in twenty bull calves experimentally infected with Bovine Petechial fever

<table>
<thead>
<tr>
<th>Day</th>
<th>AST (SF units) (range)</th>
<th>AK (KA-units) (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0*</td>
<td>42 (27-58)</td>
<td>7.6 (5-10)</td>
</tr>
<tr>
<td>1</td>
<td>45 (23-55)</td>
<td>7.1 (5-13)</td>
</tr>
<tr>
<td>2</td>
<td>34 (24-55)</td>
<td>7.1 (5-13)</td>
</tr>
<tr>
<td>3</td>
<td>43 (28-56)</td>
<td>8.7 (7-12)</td>
</tr>
<tr>
<td>4</td>
<td>62 (36-73)</td>
<td>8.7 (6-13)</td>
</tr>
<tr>
<td>5</td>
<td>93 (59-104)</td>
<td>10.3 (6-16)</td>
</tr>
<tr>
<td>6</td>
<td>105 (96-127)</td>
<td>10.9 (6-14)</td>
</tr>
<tr>
<td>7</td>
<td>122 (104-127)</td>
<td>10.4 (5-13)</td>
</tr>
<tr>
<td>8</td>
<td>159 (102-190)</td>
<td>13.4 (7-17)</td>
</tr>
<tr>
<td>9</td>
<td>142 (116-178)</td>
<td>11.9 (8-15)</td>
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<tr>
<td>10</td>
<td>145 (90-186)</td>
<td>16.4 (10-29)</td>
</tr>
<tr>
<td>11</td>
<td>147 (103-168)</td>
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<td>143 (108-174)</td>
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</tr>
<tr>
<td>13</td>
<td>114 (96-135)</td>
<td>26.9 (11-51)</td>
</tr>
<tr>
<td>14</td>
<td>98 (84-134)</td>
<td>29.2 (13-67)</td>
</tr>
<tr>
<td>15</td>
<td>85 (62-110)</td>
<td>28.3 (12-57)</td>
</tr>
<tr>
<td>16</td>
<td>96 (53-104)</td>
<td>25.2 (13-49)</td>
</tr>
</tbody>
</table>

0* — Average for 5 days before infection.
AST — Aspartate Aminotransferase
SF units — Sigma-Frankel units
AK — Alkaline Phosphatase
KA units — King-Amstrong units

ACKNOWLEDGEMENTS

We are indebted to the technical staff of the Clinical Studies Department and to Miss Lucy Muhia for typing the manuscript. This study was supported by grant No. 670/066 of the Deans’ Committee, University of Nairobi for which we are most grateful.

REFERENCES


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EFFICACY OF CHLORFEN DFF(R) AGAINST INFESTATION OF RHIPICEPHALUS APPENDICULATUS\(^1\) (NEUMAN 1901)

F.G.R. RINKANYA  
Veterinary Research Laboratory, P.O. Kabebe, Kenya

SUMMARY

The in vivo efficiency of freshly prepared Chlorfen DFF(R) as a potential ixodicide was compared with that of a known standard, Asunton(R) liquid. Both ixodicides achieved a residual protective period of two to three days after which total tick numbers on cattle started increasing remarkably. There was no significant difference between percentage control achieved by each of the ixodicides. None of these ixodicides would be able to control Rhipicephalus appendiculatus ticks by weekly spraying in the face of continuous heavy re-infestation.

INTRODUCTION

Rhipicephalus appendiculatus is a rapidly feeding three-host tick and needs a short attachment period on cattle to transmit Theileria parva. Its short attachment period on the host makes it a good indicator of the efficiency of ixodicides and their potential value. Although other means of tick control such as induced, sterility, genetic mechanisms, hormones, pasture spelling, alteration of the environment and host resistance (Drummond et al; 1974) have been proposed, ixodicides still remain the practical manner of tick control in the absence of regular vaccination against tick-borne diseases especially East Coast Fever (ECF).

In Kenya, regular application of ixodicides remains the most economical method of tick control. Before a new ixodicide is registered for use, pre-registration trials are carried out to determine its efficacy. This report describes such a study to assess the effect of a miscible oil formulation of a diluent free Chlorfen(R) containing 500ppm of the active ingredient on total tick counts on cattle infested with various stages of Rhipicephalus appendiculatus.

The active ingredient of Chlorfen (R) DFF(R) (2-chloro-1 (2-4 Chlorophenyl) vinyl phosphate has been shown to be highly effective in vitro against strains of most important tick species (Shaw and Baker, 1966). In the laboratory, the activity of an ixodicide can be assessed and can be compared with that of others but it is difficult to measure accurately its residual protection. Field tests under stringent conditions must be carried out therefore to find out whether an ixodicide potential as a tick destroying agent will be realised.

\(^1\)Aearina Ixodidae

MATERIALS AND METHODS

Tick infestations:

The trial was carried out in a double fenced paddock infested with Rhipicephalus appendiculatus ticks. The paddock was infested by evenly scattering 100,000 larvae, 75,000 nymphs and 50,000 adults on the pasture prior to the trial. Twelve tick free Jersey cattle (nine to twelve months old) were introduced into the paddock and allowed to be infested with ticks while grazing. Every week after commencement of the trial the paddock was evenly infested with 3,000 larvae, 2,500 nymphs and 2,000 adults to maintain a high tick population in the paddock. Total adult numbers on every animal was assessed by counting ticks on the whole body. After two pre-treatment counts on day seven and eight post exposure to ticks, three animals were rejected because very few ticks had attached on them. The remaining nine animals were randomly allocated to three treatment groups.

Treatment groups:

Three Jersey animals in one group were sprayed with a miscible oil formulation of Chlorfen DFF(R) (Chlorfenvinphos, General Chemical W110) containing 500ppm active ingredient (2-Chloro-1-(2-4 Chlorophenyl) Vinyl diethyl phosphate. Three Jersey animals in another group were sprayed with a miscible oil formulation of Asunton(R) (0,0-diethyl-(3-Chloro-4-Coumariny) phosphorothioate containing 500ppm active ingredient. Both ixodicides were prepared immediately before use. The remaining three Jersey animals were
unsprayed throughout the four weeks. The control count of the unsprayed group was used as an index in the calculation of the percentage tick control achieved by the ixodicides.

Spraying:

Each group of animals was sprayed using a twelve litres Solo Knapsack sprayer fitted with a fan spray nozzle (Albus: Desmarquest, F. 200 EVREUX/France). Each animal was sprayed with ten litres of the respective ixodicide.

Tick counts and Interpretation:

Post treatment counts were made on day one and then every other day. Assessment of the ixodicide efficacy was based on counts of adults, larvae and nymphs post treatment. Counting of larvae and nymphs was done by using a plastic disc with a square window of 9cm². This disc was put on an area one inch to the left side of the muzzle and all the immature ticks on the 9cm² area were counted on every animal. This method is sufficient to assess the activity of ixodicides against the immature stages of *Rhipicephalus appendiculatus* as described by Ong'are et al. 1983.

Information of the period for which cattle were protected from re-infestation by the residual toxic effects of the ixodicides were derived from rise in counts of all tick stages post treatment. Percentage control achieved by each of ixodicide was calculated by dividing the number of live ticks attached on each of the treatment group by the number of ticks attached on the control group and then multiplying by 100 as described by Wharton et al., (1970).

It was found necessary to consider only live ticks because after spraying the treatment groups, some ticks died and were still attached to the animals on day one after spraying.

**RESULTS**

Figure 1 show the percentage control of adult ticks achieved by each of the ixodicides post spraying, while Fig. 2 shows the same for the immature stages (both nymphs and larvae). Table 1 shows the mean adult tick counts for the two treatment groups and the control, while Table II shows the same for the immature stages. For both ixodicides, the percentage control waned after two to three days post spraying as evidenced by the abrupt and continued rise in total ticks there after as shown in Fig. 1 and 2. Based on the total adult numbers of ticks attached on the animals 24 hours post spraying, Chlorfen DFF(R) attained a higher rapidity of kill when compared to Asunto(R) liquid as shown in Table I and II. There was a significant difference between the mean counts for the control group compared to two treated groups (P < 0.05) for the whole duration of the experiment. However when the two treatment groups were compared with each other, the difference between the mean daily counts were not significant. The mean counts per animal changed significantly with the days post spraying for the ixodicides (P < 0.05) with the lowest numbers being observed on day one post spraying. The immature stages of the tick showed no significant change in the mean weekly counts for the three groups over the four week period while this was significant for adults (P < 0.05). Therefore the weekly larval any nymphal

<table>
<thead>
<tr>
<th>Days when tick counts were made</th>
<th>-1</th>
<th>0</th>
<th>1</th>
<th>3</th>
<th>5</th>
<th>7</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
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<th>19</th>
<th>21</th>
<th>22</th>
<th>24</th>
<th>26</th>
<th>28</th>
<th>29</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ACARICIDE</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td>Chlorfen DFF(R) 500ppm</td>
<td>1410</td>
<td>1442</td>
<td>9</td>
<td>69</td>
<td>396</td>
<td>718</td>
<td>13</td>
<td>67</td>
<td>308</td>
<td>423</td>
<td>6</td>
<td>37</td>
<td>165</td>
<td>330</td>
<td>5</td>
<td>101</td>
<td>142</td>
<td>339</td>
<td>12</td>
</tr>
<tr>
<td>Asunto(R) liquid 500ppm</td>
<td>1426</td>
<td>1412</td>
<td>44</td>
<td>93</td>
<td>460</td>
<td>594</td>
<td>44</td>
<td>69</td>
<td>147</td>
<td>421</td>
<td>14</td>
<td>71</td>
<td>274</td>
<td>322</td>
<td>31</td>
<td>140</td>
<td>382</td>
<td>390</td>
<td>30</td>
</tr>
<tr>
<td>Unsprayed control</td>
<td>1360</td>
<td>1370</td>
<td>620</td>
<td>698</td>
<td>719</td>
<td>814</td>
<td>746</td>
<td>461</td>
<td>609</td>
<td>517</td>
<td>431</td>
<td>354</td>
<td>393</td>
<td>451</td>
<td>245</td>
<td>350</td>
<td>429</td>
<td>411</td>
<td>384</td>
</tr>
</tbody>
</table>

Table 1: Mean Number of Adult *Rhipicephalus appendiculatus* counted on each group of three animals sprayed with 500ppm chlorfen DFF(R), 500ppm Asunto(R) liquid and the unsprayed control.
counts for each of the treatment group were not different from those of the control group whereas the adult counts for the treatment groups were different from those of the control group.

**DISCUSSION**

The evidence which has been presented in this paper suggest that freshly prepared wash of Chlorfen DFF(R) when used at 500ppm will exhibit a degree of activity similar to that of Asuntol(R) liquid against *Rhipicephalus appendiculatus*. However its high exhaustion rate has to be closely monitored and proper replenishment rate determined when being used in plunge dips (Rinkanya et al, 1983).

From the present study it is therefore suggested that where this new ixodicide (Chlorfen DFF(R) is going to be used for tick control and where *Rhipicephalus appendiculatus* is a major problem the regimen of hand dressing of the ears and tail brushes between dippings and twice weekly dipping should be adapted when tick infestations are high as is done with Asuntol(R) liquid.
Table II: Mean number of immature stages (Larvae and Nymphs) counted on each group of three animals sprayed with 500ppm chlorfen DFF(R), 500ppm Asunto[R] liquid and the unsprayed control.

| Days when tick counts were made | 1 | 0 | 1 | 3 | 5 | 7 | 8 | 10 | 12 | 14 | 15 | 17 | 19 | 21 | 22 | 24 | 26 | 28 | 29 |
| ACARICIDE Chlorfen DFF(R) 500ppm | 7 | 4 | 3 | 6 | 7 | 13 | 1 | 3 | 4 | 12 | 0 | 3 | 11 | 5 | 0 | 3 | 7 | 12 | 1 |
| Asunto[R] liquid 500ppm. | 10 | 2 | 4 | 6 | 6 | 13 | 1 | 5 | 4 | 12 | 1 | 4 | 9 | 5 | 1 | 5 | 10 | 15 | 1 |
| Unsprayed control | 12 | 5 | 6 | 8 | 7 | 14 | 10 | 8 | 8 | 12 | 10 | 5 | 13 | 22 | 6 | 6 | 10 | 16 | 8 |

Fig. 1 Percentage control of adult ticks after spraying.
Efficacy of chlorfen DFF(R) against infestation of Rhipicephalus appendiculatus (Neumann 1901)

ACKNOWLEDGEMENTS

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REFERENCES


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THE EFFECTS OF TRYpanosoma AND DRUGS ON THE BLOOD PRESSURE OF RATS

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SUMMARY

Swiss albino rats infected with Trypanosoma brucei strain 8/18 showed an initial hypertension in the first three days, followed by a hypotension and death as from the 5th day post infection. Treatment of infected rats two days post infection with Berenil (diminazene aceturate) produced aparasitaemia and reduced the initial hypertension. Besides, berenil (0.2-0.8) mg/ml produced a fall in the blood pressure of normal rats, and at a concentration of 100μg/ml inhibited blood pressure depression caused by both acetylcholine and histamine.

INTRODUCTION

Diminazene aceturate (a diamidine) is a widely used trypanocide in East and West Africa. It is useful both in human and Veterinary trypanosomiases. In the treatment of livestock infections, the recommended curative dose is 3.5 mg/kg body weight for 'brucei — congo lense' infections (Williamson 1962) and 7 mg/kg body weight in Trypanosoma vivax infection (Na'Isa, 1970). There have been several reports of diminazene toxicity at therapeutic and repeated doses in animals. Doses of 3.5 mg/kg body weight have produced fatal cervical lesions in East Africa (EATRO, 1970). Toxicities have also been reported at therapeutic doses in donkeys (Hill and Akpokodje, 1971) and young horses (Gill, 1964). Losos and Crockett (1969) reported death of dogs within 36 and 54 hours for those administered 15 mg/kg body weight or 60 mg/kg body weight of diminazene respectively. In rabbits diamidines have been reported to produce respiratory and circulatory failure (Lourie and Yorke 1939; Wien 1943). In view of these observed effects of diminazene, we decided to investigate the following using rats:

(a) the effects of this trypanocide on normal rat blood pressure, and its interaction with histamine, an inflammatory mediator associated with the pathogenesis of trypanosomiasis (Richards, 1965) and acetylcholine (a neurotransmitter of the autonomic nervous system)

(b) the effects of Trypanosoma brucei infection on rat blood pressure, and

(c) the effects of treatment with diminazene on the blood pressure of infected rats.

MATERIALS AND METHODS

Animals: 25 Swiss albino rats weighing between 250 and 300g, and purchased from the University of Ibadan, Faculty of Veterinary Medicine Experimental Animal Unit were used for the study. The rats were divided into three groups (I, II and III) (Table I). Group I (control group) contained 10 rats. These animals were neither infected with trypanosomes nor treated after infection with anti-trypanosomal drug, berenil. They were used to assess blood pressure of normal healthy rats, and the effects of varying doses of berenil, histamine and acetylcholine on the blood pressure. In Group II were 10 trypanosomal infected rats. The animals were used to investigate the effect of trypanosomal infection on rat blood pressure. Group III contained 5 trypanosomal drug, berenil. They were used treated with 3.5 mg per kg body weight of berenil. The group III rats were used to investigate the effect of berenil treatment on the blood pressure of infected rats.

Trypanosome: Trypanosoma brucei strain 8/18 was used in the study. It was obtained from the Nigerian Institute for Trypanosomiasis Research (N.I.T.R.) Vom, Nigeria. The strain which was first isolated in 1962 from a natural infection in pigs in Eastern Nigeria can produce death of laboratory rodents within eight days (Arowolo, 1982). It has undergone several passages in rodents before being used in the present study. Each infected rat received 2 x 10^4 parasites at the time of infection.

Preparation of rats for recording blood pressure: Each rat was anaesthetized with urethane 1.25 g/kg body weight and then
fastened to an operating table. Surgical incisions were made on the neck and the thigh region of the rat to expose and cannulate the trachea and femoral vein respectively. Drugs were injected via the femoral vein. The carotid artery located close to the trachea was carefully separated, cannulated and connected to an heparinized condon mercury manometer. To prevent blood clotting, each rat received 500 units of heparin along with 0.2ml physiological saline. Blood pressure rhythms were recorded on the kymograph drum as they were transmitted to the condon mercury manometer.

*Drugs used:* Histamine in form of histamine acid phosphate, acetylcholine in form of 0-acetylcholine chloride (all from the British Drug Houses Limited, Poole, England), and Berenil (diminazene aceturate (Hoechst Nigeria Limited, Ikeja, Lagos) were used in this study. Drug solutions were made by dissolving the powders in distilled water to make the desired drug concentrations.

**RESULTS**

The result showed that the blood pressure of Group I Swiss albino rats were 72.25 ± 3.85 mm Hg. When berenil was injected into the femoral vein of these rats, no effect was observed with 0.1 to 0.2 mg/ml of berenil solution. Berenil (0.4-0.8) mg/ml on the other hand depressed the blood pressure (Fig. 1). Acetylcholine and histamine (100-800) µg/ml also depressed the blood pressure dose-dependently (Fig. 1 and 2). Berenil (100µg/ml) inhibited these acetylcholine and histamine induced responses (Fig. 1 and 2).

When the blood pressure of infected rats (Group II) were monitored at the three days post infection, blood pressure was 99.2 ± 17.84 mm Hg. (n = 5) (Table 1). At five days post infection, only two out of the five remaining five infected rats could be monitored. The other three were found dead in the morning of the fifth day. The blood pressure of these two infected rats at five days post infection

![Fig. 1 Rat blood pressure responses to varying doses of Acetylcholine (doses x 100ug/ml) (A), the same acetylcholine responses in presence of diminazene aceturate (100ug/ml) (A + B) and (B) blood pressure responses to varying doses of diminazene aceturate (in mg/ml).](image-url)
was $45 \pm 5.2$ mm Hg.

Infected rats (Group III) treated two days post infection showed a blood pressure of $64.2 \pm 12.64$ mm Hg. ($n = 5$) (Table 1) when monitored after evidence of aparasitaemia (usually two days after treatment).

**DISCUSSION**

This study has shown that *T. brucei* infected rats developed an initial hypertension ($99.2 \pm 17.84$ mm Hg.) during the first three days and hypotension ($45 \pm 5.2$ mm Hg.) and death on the fifth day post infection. The initial rise in blood pressure may be attributed to either an augmentation of sympathetic activity or/and the occlusion of certain blood vessels (pulmonary, renal or hepatic) of the rats by the trypanosomes. The later fall in blood pressure observed may be explained in terms of trypanosome (antigen) — antibody reaction in the host. Such a reaction can release some hypotensive, pharmacologically-active substance (histamine, bradykinin and serotonin) in the host (Boreham and Goodwin 1970; Boreham and Wright 1976).
Berenil treatment of infected animals, however produced aparasitaemia, prevented the deleterious and fluctuating effect of the parasites on the blood pressure and the consequent death that could have ensued. In this study both histamine and acetylcholine depressed rat blood pressure, a result which agrees with those of Boreham and his colleagues (Boreham et al. 1970, 1976).

Besides, low concentrations of berenil per se had no effect on blood pressure, but inhibited blood pressure depression produced by acetylcholine and histamine. At high concentrations berenil depressed normal blood pressure of rats. This later behaviour of berenil agrees to some extent with the work of Wien (1943). Wien had shown that the following diamidines (phenamidine, propamidine and pentamidine) depressed the circulatory system. Cardiavascular depression is one of the toxic signs of diamidines in the rabbit (Lourie and Yorke, 1939) and it has been attributed to the release of serotonin, histamine or cholinergic agents (Wien 1943; Hawking 1963). It is thus clear from this study that berenil exhibited three types of action: an antihistamine or anticholinergic effect at low concentration, an antihypertensive effect when used to treat infected rats at the therapeutic dose level and a depression of blood pressure at high concentration.

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REFERENCES


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OBSERVATIONS ON THE TREATMENT OF PESTE DE PETITIS RUMINANTS (PPR) OF GOATS

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and
M.I. MECHA,
Department of Animal Science, University of Nigeria, Nsukka

SUMMARY

Four treatment regimens were used in the clinical management an outbreak of acute PPR among 27 goats. The use of broad spectrum antibiotics, fluid therapy, gastro-intestinal sedatives, antipyretics, antitussive and good nursing resulted in a survival rate of 43% which was much higher than in earlier outbreaks.

The problems associated with oral drug administration and intravenous fluid therapy were major constraints in effective clinical case handling while cost was considered a limiting factor in fluid therapy.

Solutions to these problems are suggested.

INTRODUCTION

Peste de petitis ruminants (PPR) is a common viral disease of goats and sheep in West Africa (Braide, 1981; Gragadencnec and Lalanne, 1942; Nduaka and Ihemelandu, 1975) and is identical with stomatitis – pneumonia-encephalitis complex (Hamdy, Dardiri, Nduaka, Breese and Ihemelandu, 1976). It has been suggested that mycoplasma capri (Onoviran Majiyagbe, Molokwu, Chima and Adegboye, 1983) and other bacterial organisms (Isoun and Mann, 1972) are co-causatives of the condition. From personal observation, PPR is the major killer disease in the goat unit of the University of Nigeria, Nsukka (U.N.N.) farm.

A survey conducted in selected farms in Imo and Anambra States of Nigeria showed that up to 57.14% of these farms were infected with PPR at the time of the survey and that the condition was a major killer disease of goats in 40% in these farms.

Although PPR infections occur under all forms of husbandry conditions, the disease produces the highest morbidity and mortality when large numbers of goats or sheep are reared together and/or following the introduction of new animals into established herds (Braide, 1981). For example, between 1974 and 1975, PPR killed all the over five hundred goats introduced into the Ubiaja goat ranch in Bendel State of Nigeria. Similarly, between December 1974 and January 1975, all the 61 goats introduced into the goat unit of the University Farm at Nsukka died of PPR. These and other similar field reports strongly suggest that PPR presents today a major constraint in large scale intensive goat production in the West African sub-region.

Some advance has been made in the understanding of the aetiology (Hamady, Dardiri, Nduaka, Breese and Ihemelandu, 1976), the clinical manifestations and pathology of the disease (Nduaka and Ihemelandu, 1973; Mormon, Orue, Gilbert, Theiry and Sow, 1956; Isoun and Mann, 1972). However, except for the pioneering work of Gilbert and Monnier, (1962) and Nduaka and Ihemelandu, (1975), very little advance has been made in the prophylactic control of the disease. Also there is at present very little documented information on the treatment of the condition. This consists mainly of the use of antibacterial drugs against the usual secondary bacterial complications and rarely fluid administration. Several field reports suggest that the administration of tetracyclines or oxytetracyclines together with fluids and vitamins could produce good results in PPR cases. However, these suggestions have not been investigated. In a recent review of PPR (Braide, 1981), no reference was made to the treatment of the condition.

It is therefore apparent that there is an urgent need to provide rational treatment regimens for the treatment of PPR cases. Such treatment should be economical, easily avai-
Housing and Feeding

The goats were housed in separate pens in groups of 3, 6, 10, 6, 1, 1 on the basis of age, sex and pregnancy for the production studies they were intended. They were fed on freshly cut forage with concentrate supplementation and they were liberally watered. The grass litter was changed at one monthly interval.

PPR Outbreak

The goats had developed the characteristic clinical signs of the acute form of the disease and four goats (in pens 2, 3 and 4) had died before they were presented for treatment. Of the remaining goats one showed no sign, while another showed only mild signs of infection. All the goats in the unit were however treated.

The clinical signs observed included pyrexia (104-106°F), mucopurulent nasal discharges, pneumonia and coughing, profuse diarrhoea, oral erosions, ocular discharges, matted eyelids and facial hair; and dehydration. These signs

Table 1: Treatment regimens used in PPR cases in goats

<table>
<thead>
<tr>
<th>Treatment Groups</th>
<th>Treatment</th>
<th>Regimens</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (3 Animals in Pen 1)*</td>
<td>Penicillin - 10,000 i.u./kg body wt for 5 days intramuscularly (i/m). Streptomycin - 10 mg/kg body wt for 5 days intramuscularly (i/m). Darrows sol.** 50 mls/kg body wt for 3 days intravenously (i/v).</td>
<td></td>
</tr>
<tr>
<td>B (5 Animals in Pen 1)*</td>
<td>Corticycline*** - 5 mls/10 kg body wt for 5 days i/m. Acetylsalicylic - two tablets twice daily for 4 days orally acid (Aspirin). Haemacel + - 50 mls/kg body wt for 2 days i/v.</td>
<td></td>
</tr>
<tr>
<td>C (9 Animals in Pen 3)*</td>
<td>Chloramphenicol - 10 ml/kg body wt for 5 days i/m. Codein sulphate++ - 2 tablets twice daily for 4 days orally. Darrows sol. - 50 mls/kg body wt for 3 days i/v.</td>
<td></td>
</tr>
<tr>
<td>D (6 Animals in Pen 4, 5, 6)</td>
<td>Metamizazine +++ - 5 mls/10 kg body wt for 5 days i/m. Talazole+++ - two tablets twice daily for 4 days orally. Acetylsalicylic acid - two tablets daily for 4 days orally. Darrows sol. - 50 mls/kg body not for 3 days i/v.</td>
<td></td>
</tr>
</tbody>
</table>

All the animals in each group were dosed with prednisolone at 2 tablets per animal twice daily (except Group B) and quinulin boluses at 1 bolus per animal twice daily for 4 days.

* - Number of animals per group at commencement of treatment.
** - B. Braun melunengen A.G. Germany.
*** - IFFA Merieux. 17 rue Bourgelat - 69223 Lyon Cedex 1-France.
+ - Hoechst. Behring Institute, Turkey.
++ - (1 tablet = 400 mg. Acetasalicylic acid + 8mg Codein Phosphate) Boots Company (Nig.) Ltd.
+++ - Fastro Biochemical Pharmaceutical Laboratories, Italy.
++++ - May and Baker.
- E.R. Squibb & Sons Ltd. Animal Health Division Middlesex.
Table 2: Summary of result of treatment of per cases of goats

<table>
<thead>
<tr>
<th>Treatment Group</th>
<th>No. of Animals at Commencement of Treatment</th>
<th>No. of Kids in Group</th>
<th>Total Adults</th>
<th>Deaths Kids</th>
<th>% of Group</th>
<th>No. Recovered</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3</td>
<td>—</td>
<td>1</td>
<td>1</td>
<td>33.3</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td>C</td>
<td>9</td>
<td>6</td>
<td>1</td>
<td>6</td>
<td>87.5</td>
<td>2</td>
</tr>
<tr>
<td>D</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>33.3</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>8</td>
<td>3</td>
<td>8</td>
<td></td>
<td>12</td>
</tr>
</tbody>
</table>

were similar to those reported by Nduaka and Ihemelandu, (1973).

Treatment Regimens used

The animals were divided into four treatment groups (Table 1) but were left in the pens to which they were originally assigned for the production experiment.

Oral administration of drugs (Table 1) was difficult as the goats struggled and spilled the drug a lot. Similarly, intravenous fluids administered was tedious, time consuming and could be achieved only after the goats have been mildly sedated using xylazine intra-muscular injections.

RESULTS

Response to Treatment

Twelve out of the 22 sick goats (54.5%) died of the disease between 1-5 days of treatment. These consisted of 8 kids less than 6 months old and four goats more than 6 months old.

Group A: The rectal temperature subsided gradually from 105 ± 0.8°F on the first day to 101.5 ± 1.5°F on day 5 of treatment. The pregnant goat in this group showed a subsequent temperature rise to 106.0°F on day 6 and aborted on day 7 of treatment. The cough, nasal discharge and respiratory distress all disappeared between day 2 and 5 of treatment while the diarrhoea seen in one case, ceased on day 2 of treatment. The single fatality in this group occurred on day 4 of treatment.

Group B: From a range of 104.2-105°F on the first day of treatment, the rectal temperature subsided to 100.0-101.8°F between day 5 and 7 of treatment. There was a continuous fall in rectal temperature in all animals except a day preceding abortion crises in two pregnant animals. The cough persisted till the 11th-14th day of treatment although there was an early cessation of nasal discharges. The diarrhoea was adequately controlled between day 3-6 of treatment, one kid died in this group. The appetite of the remaining animals improved on day 2-3 and was normal on day 5-6 of treatment.

Group C: Seven of the eight kids died (1 on the 2nd, 3 on the 3rd and 3 on the fourth days of treatment). One died from aspiration pneumonia during drenching while two did not recover from xylazine sedation. The only survival in this group, responded similarly as survivals in groups A and B in respect of rectal temperature, appetite, bowel motion and remission of coughing. One of the kids that died had sub-normal rectal temperature (98.6°F) a day before death, while in three other cases, there was a sudden rise in the rectal temperature (103.4-104.2°F) a day before death. The cough, diarrhoea, nasal discharges and anorexia improved only slightly before death.

Group D: The elevated rectal temperature (105 ± 1.8°F) returned to normal (101.5 ± 1.5°F) between day 4 and 6 of treatment. The only fatal case in this group died a day after a fall in the rectal temperature to a sub-normal level (97.6°F). In this group, the cough persisted till day 13 in two cases but
the severe diarrhoea seen in one case was satisfactorily controlled on day 6 of treatment. No specific treatment was given for the labial scabs or oral erosions.

DISCUSSION

The recovery rate of 45.5% obtained in the present cases is higher than the possible 5% reported by Braide, (1981) and an average of 33.3% reported by Obi, (1981) but lower than the 60.9% reported in a population of goats protected with TCRV (Opasina, 1981). Within the University Farm, the survival rate reported in this study was the highest ever recorded even though the weather was most adverse throughout the duration of the outbreak—a condition which, in our experience, increases the severity and fatality of PPR cases.

The result of the present work suggests that clinical cases of PPR can be adequately and successfully treated even in advanced cases as in this outbreak. Certainly better result can be obtained if treatment is started early.

It is significant that all the kids died even though they were given the same treatment as the adults. The high kid mortality was due to rough handling (Obi, 1980), accidents (aspiration pneumonia) during oral drug administration and the peracute nature of the disease in kids (Nduaka and Ihemelandu, 1976; Braide, 1981). The 100% kid mortality accounted for the low survival rate in the entire population as the actual mortality rate among adults was 20%.

The results of this study suggest that a rapid lowering of the body temperature using antipyretic drugs and the suppression of coughing using antitussives enhance the chances of successful therapy. The profuse diarrhoea and complete anorexia seen in these cases, resulted in severe dehydration, gross ionic imbalance, probably in a bicarbonate and potassium ion loss and acidosis. Prompt arrest of the diarrhoea and replacement of the lost body fluids and ions would appear to be more important than the use of antibacterial agents. This is borne out from the results of this study and supported by the fact that PPR is a viral condition.

The result in Group B suggests that fluid volume replacement may be more critical than specific ion replacement in such cases.

The rapid improvement in appetite, cessation of diarrhoea, recovery from respiratory dysfunction and the high survival rate in this report is in contrast to the long convalescence and the high mortality rate usually associated with PPR in goats. In our experience, a return of appetite is a reliable indicator of recovery from the condition.

However the difficulty associated with oral administration of drugs and intravenous fluid administration are major constraints in the clinical management of caprine PPR. The use of sedation as an aid to intravenous fluid therapy in PPR affected goats should be reassessed with regard to drug safety and the ability of such animals to recover from such sedation.

Although fluids can be administered intra-peritoneally or subcutaneously (Obi, 1980) as an alternative to intravenous fluid infusion, it is suggested that in view of cost, the possibilities of oral administration of both fluids and some drugs be investigated. This is important considering that most PPR cases are seen in the field and that large numbers of animals may need to be handled. The use of locally prepared non-sterile fluids would drastically cut down on the cost of treatment and the over all capital cost of production.

Presently, such techniques as stomach intubation, naso-ruminal or naso-abomasal intubation, pharyngostomy, ruminal fistulation or duodemostomy are being investigated as alternative routes for drug and fluid administration in caprine PPR.

REFERENCES

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INVESTIGATION ON CAMEL HAEMONCHOSIS IN THE EASTERN REGION OF SUDAN

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SUMMARY

120 camel gastro-intestinal tract collected from Elgadarif slaughter house was examined for parasitic infection. 67% of the examined cases were found infested with Haemonchus, 15.8% Strongyloids and 5% Trichuria.

The effect of haemonchus on 161 camel abomasae was investigated. The histopathological, and epidemiological aspects of the disease were discussed.

INTRODUCTION

Camel production in the Sudan is now one of the important resources. The ever increasing prices of racing camel in Arabian market, has promoted a great concern in developing the conventional system of camel raising and husbandry (Acland, 1932, Gillespie, 1962). In the eastern region of the Sudan where a dense camel population exists and the recent ecological changes in camel grazing areas, parasitism is of considerable interest. Since the early report of Steward (1950) in which camel infection with Haemonchus was recognized as a major problem only meagre studies concerning haemonchosis have been carried out (Eisa et al 1979).

The present study is intended to highlight the incidence of Haemonchus and its effect on camel in the eastern region of Sudan in relation to recent development.

MATERIALS AND METHODS

Experiment 1

120 camel gastro-intestine tracts including abomasum small and large intestine were washed on a 40-mesh screen, and the residue was carefully examined for small parasites under a x3 floating magnifying glass. The remainder was washed on a 20-mesh screen and picked through under the x3 glass for large parasites using the technique described by Grudge et al (1963).

Experiment 2

Antimortem faecal egg count of 161 camels was carried out using the method of Gordon Witlock (1939). Abomasae of these camels were collected from Elgadarif slaughter house (5-10 abomasae daily). The worm burden was then estimated as described by Drudge et al. (1963), and categorized as heavy, medium and light infection. Portions of inflamed parts of abomasae were fixed in 10% formal saline, embedded in paraffin wax, sectioned and stained with Hematoxylin and Eosin.

RESULTS

Experiment 1

The prevalence of infection of camel with various worms has shown that 67.5% of camels were infected with Haemonchus (Table 1). The records of camels investigated herein showed that they originated from various parts of the eastern region.

Experiment 2

The frequency of infection with Haemonchus is shown in Table 2. The largest number of haemonchus worm was found in 10 camel abomasae (681 worms) while the majority of abomasae contained less than 26 worms. 33 abomasae were found to contain an average number of 169 worms.

Histopathology

In heavy, medium and light infestation, the lesions were confined to the mucosa. It is characterized by severe congestion of capillaries in the mucous neck region which may be accompanied by infiltration of inflammatory cells mainly plasma cells or eosinophils (Fig. 1). In some occasions necrosis of the mucous neck cells and replacement by intense infiltration of plasma cells and eosinophils was observed (Fig. 2).
Table 1: Distribution of worm infection in 120 camel gastrointestinal tract from Elgadarif slaughter house

<table>
<thead>
<tr>
<th>No.</th>
<th>Type of worm</th>
<th>No. of gastro-intestinal tract examined</th>
<th>% Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Haemonchus</em> longistipes</td>
<td>81</td>
<td>67.5</td>
</tr>
<tr>
<td>2</td>
<td><em>Trichostrongylus</em> spp.</td>
<td>19</td>
<td>15.8</td>
</tr>
<tr>
<td>3</td>
<td><em>Trichuris</em> spp.</td>
<td>6</td>
<td>5.0</td>
</tr>
<tr>
<td>4</td>
<td>Mixed infection (1, 2)</td>
<td>10</td>
<td>8.3</td>
</tr>
<tr>
<td>5</td>
<td>Not identified</td>
<td>4</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Table 2: The frequency of infection in camels with *Haemonchus* in Elgadarif slaughter house

<table>
<thead>
<tr>
<th>No. of camel abomasae</th>
<th>Average No. of worm ± S.D.</th>
<th>Ova/gram ± S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>10+++</td>
<td>681 ± 6</td>
<td>581 ± 16</td>
</tr>
<tr>
<td>33++</td>
<td>169 ± 9</td>
<td>420 ± 7</td>
</tr>
<tr>
<td>118+</td>
<td>26 ± 10</td>
<td>89 ± 9</td>
</tr>
</tbody>
</table>

+++ = heavy infection  
++ = medium infection  
+ = light infection  
S.D. = standard deviation

**Fig. 1.** Note congestion and plasma cells.

**DISCUSSION**

The result of this investigation confirm the findings of Eisa *et al* (1979) that (haemonchus is present and is widespread amongst camels in the eastern region of the Sudan. It also suggests that the incidence is higher than that reported by Stewards (1950). In his survey, Altaif (1974) has shown that the Iragli camel suffer mainly from *Trichostrongylus* and not *Haemonchus*. Although individual count of worm infection was done, their exact burden on camel health was not properly estimated (Altaif, 1974). Camel owners call the disease Hollaa and they claim that herds infected with *Haemonchus* suffer from weakness, low milk
production, diarrhoea in young ones and sluggish movement. Steward (1950) and Malek (1959) claimed that deaths in camels were due to *Haemonchus*. As this work was done during the dry season, the number of worms infesting camels in the wet season will probably exceed these numbers, however, it is not known whether *haemonchus* will preserve the same high percentage of infection.

Histopathological findings indicated that worm burden does not correspond with the lesions elicited. Heavily infested camels had slight reaction and vice versa. This discrepancy could be attributed to the local immune response produced by plasma cells present in the area. Whether these cells of inflammation participate in the outcome of clinical symptoms of the disease, a more detailed study is needed. The recent increase of infection in Eastern camel with this parasite might be due to changes in the grazing behaviour; camels used to graze from upper bushes and rarely from the ground where the chances of larval intake exist. The removal of bushes for agricultural expansion resulted in the camels feeding from ground and increased chances of picking ova dropped on the pasture. Larval count in pasture will probably clarify this assumption. The view that desert sheep and goats, the major hosts for *haemonchus* (Eisa et al, 1979), raised together with camels are the source of contamination of pasture and thus camels need to be verified in order to understand some aspects of epidemiology regarding this disease. The outcome of these studies might also result in a better means for controlling the disease and lessening the indiscriminate use of chemo-therapy by the camels owners.

**ACKNOWLEDGEMENTS**

The authors wish to thank the province and district officers of Kassala and Elgardarif of the Sudan for providing facilities for this work. We also thank Director, Veterinary Research Administration for encouragement and the Permanent Under Secretary, Animal Resources, for his permission to publish the manuscript.

**REFERENCES**


Received for publication on 24th May, 1983
The results of this investigation confirm the findings of Cai et al. (1970) that stimulation of a particular area of the hippocampus caused an increase in the levels of a certain chemical. This suggests that the hippocampus plays a role in memory, either by storing or retrieving information.

Fig. 1. Hippocampal stimulation and memory recall.

Fig. 2. Hippocampal damage and changes in behavior of the animal (1970).
Geographical Distribution of Avian Pasteurellosis in Africa/
Distribution Geographique de la Pasteurellose Aviaire en Afrique

- Foci reported
- Foyers signalés

- Widespread
- Répandu dans le pays

- Enzootic/Sporadic but no Foci reported
- Enzootique/Sporadique mais pas de Foyers signalés

- No official Information available
- Pas d'information officielle disponible

Geographical Distribution of Salmonellosis FT in Africa/
Distribution Geographique de la Typhone Aviaire en Afrique

OAU/STRC
CSTR/OUA
INTERAFRICAN BUREAU FOR
ANIMAL RESOURCES/
BUREAU INTERAFRICAIN DES
RESSOURCES ANIMALES
MAP/CARTE NO.

19

Foci reported
Foyers signales

Widespread
Répandu dans le pays

Enzootic/Sporadic but no Foci
reported
Enzootique/Sporadique mais
pas de Foyers signales

No official Information
available
Pas d'information officielle
disponible

Geographical Distribution of Streptothricosis in Africa/
Distribution géographique de la Streptothricose en Afrique

- **Foci reported**
  - Foyers signalés
- **Widespread**
  - Repandu dans le pays
- **Enzootic/Sporadic but no Foci reported**
  - Enzootique/Sporadique mais pas de Foyers signalés
- **No official Information available**
  - Pas d'information officielle disponible

Geographical Distribution of Anoplasmosis in Africa/
Distribution Geographique de l'anoplasmosis en Afrique

- Foci reported
- Widespread
- Enzootic/Sporadic but no Foci reported
- No official information available

Geographical Distribution of Bovine Trypanosomiasis in Africa/
Distribution Geographique de la Trypanosomose Bovine en Afrique

- Foci reported
- Widespread
- Enzootic/Sporadic but no Foci reported
- No official information available

BULLETIN OF ANIMAL HEALTH AND PRODUCTIONS IN AFRICA

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Vol. 32 No. 4 – Nos. 85–110

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T. MATTILA, P. MAISI, & SANDHOLM

Haem compounds as bacterial growth promoters in whey: A possible application to bovine mastitis.

Res. in vet. Sci., 1984, 36 (1) 52.

AUTHOR'S SUMMARY: The enhancing effect of haem compounds on the growth of Escherichia coli, Staphylococcus aureus and Streptococcus agalactiae in whey cultures was studied turbidometrically. Catalase, myoglobin and haemoglobin in concentrations 10^-5 to 10^-3 M enhanced bacterial growth. One explanation of this was the availability of iron by these haem compounds for the bacteria. However, evidence from experiments on free radical generating systems by t-BHP and hydrogen peroxide indicated that haem compounds scavenge activated oxygen products and so protect bacteria for oxygen toxicity.

E. MOMOTANI, S. INUI, Y. ISHIKAWA and R. AZUMA

Granulomatous Sub-dermal Lesions in Sheep Inoculated with Dermatophilus congolensis.

J. Comp. Path., 1984, 94 (1) 33.

AUTHOR'S SUMMARY: Dermatophilus congolensis was inoculated subcutaneously into 6 ewes and the resulting lesions were examined by light and electron microscopy. The organism was recovered from the sub-cutaneous lesions. The lesions were suppurative in the early stages and granulomatous in the advanced stage, but abscesses were the usual lesion observed. The granulomas were composed of several layers; central bacteria colony, neutrophil layer, layer of macrophages epithelioid cells and Langhans and foreign body type giant cells with a periphery of connective tissue. Multiloculated granulomas were observed. Electron microscopic examination confirmed the cell types of the lesions. Epithelioid and giant cells were characterized by the shape and number of the nuclei and complex and abundant organelles. Interdigitations of the blunt pseudopodia of adjacent cells were also found. It is concluded that the organism can produce both granulomatous lesion and abscesses which differ from those of orthodox dermatophilosis but are similar to those described in "atypical dermatophilosis".

A.J. FROST, B.E. BROOKER & A.W. HILL

The effect of Escherichia coli endotoxin and culture filtrate on the lactating bovine mammary gland.


AUTHOR'S SUMMARY: The pathogenesis of coliform mastitis was studied by observing pathological changes in lactating glands after infusion of either endotoxin or the sterile culture filtrate (CCF) of the medium in which Escherichia coli strain B117 had been grown. Both infusions produced a rapid and intense inflammatory response by 4 h with a marked increase of serum proteins in the milk. Before dispersing into the milk, neutrophils were attached to the ductular epithelium; highest cell counts in the milk were recorded when the tissue reaction had waned. Oedema of the ductular epithelium occurred, particularly where neutrophils were actively migrating. The infusion of CCF produced, in addition to inflammation, degeneration and necrosis of ductular cells. The smallest lesions healed very rapidly. There was evidence of differing cell susceptibility to the necrotising toxin as well as uneven distribution over the epithelial surface. All changes observed were confined to the regions of the teat and lactiferous sinuses with little effect on the secretory tissue. The role of the necrotising toxin in the natural disease remains undetermined.

R.A. BREWER, F.A. STUART & M.J. CORBEL

An indirect example enzyme-linked immunosorbent assay for the detection of antibodies to Brucella abortus in porcine sera.


AUTHOR'S SUMMARY: An indirect enzyme-linked immunosorbent assay (ELISA) is described for the detection of brucellosis in pigs. The combination of a commercial goat anti-rabbit peroxidase conjugate and an experimentally-prepared rabbit anti-porcine immunoglobulin serum detected both IgM and IgG antibodies to Brucella abortus in pigs. The test gives results comparable with the Coomb's antiglobulin test but is more rapid and uses very small volumes of reagents.

F.A. CLIFTON-HADLEY & M. R. ENRIGHT

Factors affecting the survival of Streptococcus suis type 2.

The vet. record, 1984, 114 (24) 585.

AUTHOR'S SUMMARY: The survival of Streptococcus suis type 2 was assessed in experimentally inoculated faeces and dust stored at 0, 9 and 22 to 25°C. The organism survived in faeces for 104 days at 0°C, up to 10 days
at 9°C and up to eight days at 22 to 25°C. It survived in dust for up to 54 days at 0°C and up to 25 days at 9°C but could not be isolated from dust stored at room temperature for 24 hours. The organism survived at 4°C in nutrient medium for up to nine months but in distilled water for only one to two weeks. At 50°C it survived in water or broth for up to two hours but at 60°C it only survived for 10 minutes. The organism was rapidly inactivated by disinfectants and cleaners, commonly used on farms and in laboratories, at concentrations less than those recommended for use by the manufacturer.

IBAR/1984 H.V.S. CHAUHAN & K.C. VERMA
90 Evaluation of Cell-mediated Immunity to Marek's Disease.


AUTHOR'S SUMMARY: Studies on the possible role of cell-mediated immunity (CMI) in the various immunoprophylactic and control groups indicated that CMI played a dominant role in resistance to Marek's disease. Total and T lymphocyte counts, dinitrochlorobenzene test and graft versus host reaction were used to evaluate the CMI.

IBAR/1984 H.J.C. CORNWELL, S.D. PATerson, I.A.P. MC-CANDiLISH, H. THOMPSON and N.G. WRIGHT
91 Immunity to Canine Adenovirus Respiratory Disease: Effect of Vaccination with an Inactivated Vaccine

The vet. Record, 1983, 113 (22) 509-512

AUTHOR'S SUMMARY: Nine puppies without maternal antibody to canine adenovirus (CAV) were divided into two groups. The first consisted of six puppies, each of which was given two doses of a commercial inactivated CAV-1 vaccine, 14 days apart. Eight days after administration of the second dose of vaccine, all six puppies, together with the second group, consisting of three unvaccinated controls, were challenged with an aerosol of virulent CAV-2. One dog from each group was killed on the third, fifth and 10th days after challenge and the three additional vaccinates killed at intervening times. All of the dogs developed respiratory signs, mainly coughing and tachypnoea, but the vaccinated dogs made a more rapid recovery. The lungs of both groups were consolidated, the areas affected being more extensive in the controls, and histological examination revealed the main lesion to be a severe necrotising bronchiolitis. Virus was isolated from the respiratory tissues and from throat swabs collected from both groups of dogs. The presence of neutralising antibody in the serum was not, of itself, sufficient to control viral replication and obliterate the disease.

IBAR/1984 P.G. JOSEPH & R.S. HEDGER
92 Serological Response of Cattle to Simultaneous Vaccinations Against Foot-and-Mouth Disease and Haemorrhagic Septicaemia

The vet. record, 1984, 114 (20) 494.

AUTHOR'S SUMMARY: In Malaysia, where vaccination campaigns against foot-and-mouth disease and haemorrhagic septicaemia are routinely carried out, it was desirable to determine whether it was safe and efficacious to administer both vaccines simultaneously. A trial group of 104 cattle was divided into three groups; group 1 animals received both vaccines simultaneously, group 2 animals received only foot-and-mouth disease vaccine and group 3 animals received only haemorrhagic septicaemia vaccine. The serological response to vaccination was monitored at 0, 21 and 35 days by the virus neutralisation test for foot-and-mouth disease and the mouse protection and indirect haemagglutination tests for haemorrhagic septicaemia. The simultaneous administration of the two inactivated vaccines produced no adverse effects and the serological response did not differ from the response to either vaccine given separately, thus indicating that cattle may be safely and effectively vaccinated simultaneously in this way.

IBAR/1984 L. BLACK, M. RWEYEMAMU and A. BOGE
93 Revaccinating Response of cattle as a function of the 140S foot-and-mouth disease antigen dose


AUTHOR'S SUMMARY: Fifty adult cattle were subdivided in 2 equal groups and inoculated with foot-and-mouth disease vaccines containing either 5 µg or 0.01 µg of 01 BFS 1860 140S antigen per 3 ml dose. Four months later they were subdivided into groups of 5 and injected with vaccines containing concentrations of the 140S antigen ranging from 54 µg to 7 ng per 3 ml dose. Bleedings were carried out periodically and the serum neutralizing antibody titres showed that the revaccination responses were influenced by the dose of 140S antigen in both the primary and secondary vaccinations. A linear log relationship was demonstrated between the anamnestic serum antibody long response and the dose of antigen in the secondary vaccines.
IBAR/1984  H.W. REID, D. BUXTON, E. BERRIE, I. POW and J. FINLAYSON
Malignant catarhal fever

The vet. record, 1984, 114 (24) 582.

AUTHOR’S SUMMARY: Malignant catarhal fever is briefly reviewed and recent findings and described. Initially the disease was observed as a disease of cattle in Europe where, although no cause could be identified, circumstantial evidence implicated sheep as a source of infection and it was thus designated ‘sheep-associated’ malignant catarhal fever. Subsequently the disease was observed in Africa where it became evident that a herpesvirus which normally infects wildebeest was the cause. It is now apparent that deer are highly susceptible to both forms of the disease, the sheep associated form being a serious problem in farmed deer. The wide spectrum of clinical and pathological changes that occur in affected deer are described. A major constraint to studies of sheep-associated malignant catarhal fever has been the absence of an experimental laboratory system. However, from affected deer it has been possible to transmit the disease to rabbits and thus has allowed detailed pathogenesis studies to be made which are summarised in this paper. It is suggested that the agent of sheep-associated malignant catarhal fever is a virus and that when a particular subpopulation of T-lymphocytes is infected a profound immunological perturbation results; the lesions of malignant catarhal fever being explained by a benign T-lymphocyte hyperplasia accompanied by a deregulation of cytotoxic natural killer lymphocytes that gives rise to tissue necrosis.

IBAR/1984  A.O. AGANGA and A.A. ORTESE
A serological survey of Toxoplasma gondii in pet dogs in Nigeria

Br. vet. J., 1984, 140 (2) 207

AUTHOR’S SUMMARY: A serological survey for Toxoplasma gondii infection amongst pet dogs in Zaria, Nigeria was conducted using the indirect haemagglutination technique. Sera were obtained from 100 dogs brought to the Ahmadu Bello University Clinic. Thirty-seven of the dogs tested were seropositive at the screening dilution of 1:64, using the Wellcome ToxHA(R) kit. No statistically significant difference was observed between males and females or between age groups (P < 0.05). The high prevalence of dogs with antibody and the large number of cats, the definitive hosts of T. gondii, in Zaria suggest that more detailed epidemiological studies of this disease need to be conducted in the area.

IBAR/1984  A.M. SAAD, M.F. HUSSEIN, J.D. DARGIE and M.G. TAYLOR
The pathogenesis of experimental Schistosoma bovis infections in Sudanese sheep and goats


AUTHOR’S SUMMARY: The pathogenic effects of experimental Schistosoma bovis infection in Sudanese sheep and goats were investigated by a variety of clinical, parasitological, pathological and histopathological techniques; uninfected animals of each species were used as controls. Infected animals of both species lost or failed to gain weight and developed a haemorrhagic diarrhoea, inappetence, marked anaemia, hypoalbuminaemia, hyperglobulinaemia, hyperproteinaemia and eosinophilia. These changes first become noticeable around the time of onset of oviposition and their severity was generally related to faecal egg counts. Red cell breakdown and albumin catabolism were much higher in infected than in control animals of the same species, and it was concluded that these changes were due to haemorrhage resulting from the expulsion of large numbers of eggs through the intestinal cecarciae, both the number of worms reaching maturity and the tissue egg counts tended to be higher in sheep than in goats. On the other hand, goats had significantly higher faecal egg counts than sheep and it is suggested that this was the reason for the generally more severe disease in the former species.

IBAR/1984  F.L. MUSISI, F. JONGEJAN 97 R.G. PEGRAM and G. MUNYAMA
Isolation and transmission of Theileria mutans (Chisamba) in Zambia

Res. in vet. Sci., 1984, 36 (1) 129

AUTHOR’S SUMMARY: Theileria mutans (Chisamba) was isolated from a steer at Chisamba Central Province, Zambia by inoculation of blood into a susceptible unsplenectomised calf. The parasite was then transmitted on three occasions by nymphs and once by adult Amblyomma variegatum ticks. Macrocystic, typical for T mutans, were detected in two calves for short periods. The parasite caused varying degrees of anaemia in all experimental calves, whose sera showed high antibody titres to T mutans in the indirect fluorescent antibody test.
IBAR/1984 C. SALAU DAUDU and V. SHOYINKA
98 Scrotal circumference, daily sperm production and epididymal spermatozoa of the indigenous Bunaji and Sokoto Gudali bulls in Nigeria


AUTHOR'S SUMMARY: Testicular and epididymal tissues were obtained from 10 Bunaji and 10 Sokoto Gudali bulls aged four to five years. Testicular weights (paired sides) were 298.71±12.55 and 412.94±14.94 for the Bunaji and the Sokoto Gudali bulls respectively. Scrotal circumferences, as determined on live animals, were 34.12±0.42 and 34.54±0.65 cm for Bunaji and Sokoto Gudali bulls respectively. Scrotal circumference was positively correlated to the testicular and caudal epididymal spermatozoa in both breeds. Daily sperm production was estimated to be 4.15×10^9 and 3.67×10^9, while epididymal transit times were 4.18 and 5.71 days from Bunaji and Sokoto Gudali respectively.

IBAR/1984 O.M. KERR and W.J. McCAGHEY
99 Tail painting technique as an aid to oestrus detection in cattle


AUTHOR'S SUMMARY: The value of heat detection by tail painting was assessed by simultaneous visual observation and regular plasma progesterone assay in grazing animals; 88.1 per cent of all heats were accompanied by a positive tail paint record and 30.1 per cent of positive tail paint records occurred in dioestrous animals. Conception rates to the first insemination were 57.6 per cent and 57.9 per cent for heifers and cows, respectively. Of seven animals which showed behavioural oestrus but had intact tail paint three conceived following insemination. These results suggest that tail paint may be a useful aid in heat detection.

IBAR/1984 W.A. DEWAR and J.N. DOWNIE
100 The zinc requirements of broiler chicks and turkey poult's fed on purified diets

Br. J. of Nutr., 1984, 51 (3) 467

AUTHOR'S SUMMARY: Chicks and turkey poult's were fed for 3 weeks on low-zinc diets, prepared from purified ingredients, supplemented with zinc oxide at graded levels.

Birds of both species given the unsupplemented basal diets grew poorly, with high mortality rates. All had severe hyperkeratosis but bone development was normal. Only when birds received diets with low concentrations of added Zn were leg abnormalities observed.

Zn requirements were assessed visually from dose-response graphs. The chick required 18 mg Zn/kg diet for maximal live weight and 24 mg Zn/kg for maximal Zn concentration in blood serum. The responses of tibial Zn and net retention of Zn did not reach plateaux within the range of dietary Zn concentrations studied. The turkey poult's Zn requirement for maximal live weight was 25 and 28-29 mg/kg for net retention of Zn and for maximal concentration of Zn in blood plasma and in the tibia 41 mg Zn/kg diet was required for maximal Zn in blood serum.

Liver Zn was not correlated with dietary Zn in either species.

IBAR/1984 CAROLINE M. POND, CHRISTINE A. MATTACKS and DAWN SADLER
101 The effects of food restriction and exercise on site-specific differences in adipocyte volume and adipose tissue cellularity in the guinea-pig

1. Superficial and intra-abdominal sites

Br. J. of Nutr., 1984, 51 (3) 415

AUTHOR'S SUMMARY: The volume and number of adipocytes were measured in fourteen anatomical sites of adult guinea-pigs kept in small cages and fed ad lib., kept in small cages and on restricted diet or fed ad lib. and exercised.

In the sedentary ad lib.-fed animals, there was no significant correlation between percentage body-weight as adipose tissue, as determined by direct dissection, and mean adipocyte volume based on samples from many different sites. The correlation was significant, though not high, for sedentary, restricted-diet animals and for exercised specimens.

The correlations between the volume of adipocytes from left-right pairs of sites, and from sites around the same limb, were highly significant under all conditions studied. The correlation between the volume of adipocytes from sites other than left-right pairs of sites was weaker and in some cases statistically insignificant in sedentary ad lib.-fed guinea-pigs. The volumes of adipocytes from sites in the groin region, the mesenteries and medial to the trapezius muscle failed to correlate
in many cases with the volume of adipocytes from other sites samples.

The number of adipocytes at each site was similar in the exercised and sedentary ad lib.-fed animals. The restricted diet, sedentary group had fewer adipocytes at all sites studied except the omental and mesenteric fat mass and the groin sites.

It is suggested that moderate regular exercise or fasting gives rise to closer coordination between adipocytes at different sites because central factors regulating adipocyte volume become more prominent than local factors.

**IBAR/1984**

L. ESCOULA, C. MACOMBE, M. COSTE and N. BRUNEL

Analogy between antibiotic resistance pattern of fecal bacilli coli in ewes and their lambs


**AUTHOR’S SUMMARY:** Between ewes and their lambs born single (Charmoise species) or double (Romanov species), the authors showed some analogy of antibiotic resistance pattern of fecal E. coli. Consequently the selection pressure achieved by therapeutical treatments on ewe before and during its pregnancy, may affect the antibiotic resistance spectrum of bacilli coli flora in young animals and may have some impact on further prophylactic programmes efficiency.

**IBAR/1984**

S.M. MWAKIPESILE, C.W. HOLMES and Y.F. MOORE

Antibiotic Therapy for Subclinical Mastitis in Early Lactation; Effects of Infection, Somatic cell Count and Milk Production


**AUTHOR’S SUMMARY:** Cows with consistently high somatic cell counts (SCC) and bacterial infection, but no clinical signs of mastitis, were identified early in lactation. Some of these quarters were treated with Cloxacillin, while other similar quarters were left untreated. Prior to treatment, 74% of infected quarters had SCC higher than 300,000 cells/ml while 85% of uninfected quarters has SCC lower than 300,000 cells/ml.

Infection was eliminated by treatment in five out of eight quarters treated with Cloxacillin, and in these quarters SCC decreased from 4,200,000 cells/ml before treatment to 160,000 cells/ml after treatment.

Milk production and composition were not affected significantly although production was about 14% higher in treated quarters than untreated quarters.

The possible role of antibiotic therapy for subclinically infected quarters early in lactation was discussed in relation to a reduced rate of new infection in a herd.

**IBAR/1984**

S. MOSS and A.J. FROST

104 The resistance of chemotherapeutic agents of *Escherichia coli* from domestic dogs and cats.

*Aust. vet. J.*, 1984, 61 (3) 82.

**AUTHOR’S SUMMARY:** The prevalence of antibiotic resistant *Escherichia coli* in the rectal flora of 168 healthy dogs and 93 cats in the Brisbane area was investigated. Rectal swabs were plated on MacConkey agar with and without antibiotics, and 690 isolates confirmed as faecal *E. coli* were tested for resistance to tetracycline, streptomycin, chloramphenicol, ampicillin, neomycin, furazolidone and sulphanilamide. Resistant isolates were obtained from 101 (60%) of the dogs and 24 (26%) of the cats sampled. A high percentage of the isolates was resistant to tetracycline, streptomycin, ampicillin and sulphanilamide. Multiple resistance to 3 or more of the drugs was exhibited by the majority of isolates and a total of 31 different multiple resistance patterns was demonstrated. Of the 50 strains tested for transfer of resistance, 30 (60%) transferred some or all of their resistance determinants to an *E. coli* K12P- recipient.

**IBAR/1984**

R.S. JONES and R.D. GLEED

105 Effect of prior administration of suxamethonium on non-depolarising muscle relaxants in the dog

*Res. in vet. Sci.*, 1984, 36 (1) 43.

**AUTHOR’S SUMMARY:** The depolarising muscle relaxant suxamethonium (0.3 mg kg⁻¹) was administered to six dogs. At 50 per cent return of the neuro-muscular activity, as measured by the train-of-four technique, a non-depolarising muscle relaxant was administered. Three drugs, alcuronium (0.1 mg kg⁻¹), gallamine (1.0 mg kg⁻¹) and pancuronium (0.06 mg kg⁻¹) were injected intravenously. At the 50 per cent return of neuro-muscular activity, atropine and neostigmine were administered to reverse the neuromuscular block. The duration of action of the three non-depolarising relaxants was reduced by the prior administration of suxamethonium.
IBAR/1984  P.B. ENGLISH
106 Plasma concentration and disposition of antimicrobial agents in the dog

_Aust. vet. J., 1983, 60 (12) 353._

AUTHOR'S SUMMARY: Although there is sufficient information on the pharmacology and therapeutic application of the antimicrobial drugs to permit their effective use, they are still often misused in canine practice. This paper collates the data on drug dose rate/plasma concentration relationships observed in dogs after the administration of specific members of the major antimicrobial drug groups and on the possible impact on drug disposition (distribution and elimination) on therapeutic effect. Some information gleaned from studies in other animal species is added.

IBAR/1984  M.W. FOX
107 Towards a philosophy of veterinary medicine

_Vet. record, 1984, 115 (1) 12._

AUTHOR'S SUMMARY: The question of animal rights is looked at from a new perspective: animals of similar sentence should be entitled to the same quality of veterinary care and ought not to be treated differently, some more or less humanely than others. The ethical inconsistencies in the moral status of animals in society, and the veterinarian's role and responsibilities, are explored in an attempt to reconcile the dialectic of animal exploitation and animal rights and of the extrinsic and intrinsic worth of animals. The veterinary profession is in the centre of this issue, which necessitates an examination of our profession's ethics and the formulation of a veterinary philosophy. The importance of empathy in the art and practice of veterinary medicine is also discussed.

IBAR/1984  F.A. EALES, J. SMALL, I.A. DICKSON, M.E. SMITH and A.W. SPEEDY
108 Effectiveness in Commercial Practice of a New System for Detecting and Treating Hypothermia in Newborn Lambs

_The vet. record, 1984, 114 (19) 469._

AUTHOR'S SUMMARY: A new system for the detection and treatment of hypothermia in newborn lambs was evaluated on 30 commercial farms. This system comprised the detection of hypothermia with the aid of an electronic thermometer, the reversal of hypo-glycaemia in lambs aged more than five hours by an intraperitoneal injection of glucose solution, warming in air at 40°C and careful management after warming. Of all lambs treated, 69 per cent were alive one week later. The majority of lambs which were treated and lived were subsequently reared on ewes. Treatment was more successful in lambs aged less than five hours (76 per cent) than in older lambs (64 per cent). Higher success rates were recorded when the hypothermia was detected in the temperature range of 37.0 to 39.0°C (83 per cent) than when it was only detected at a temperature of less than 37.0°C (65 per cent). Twins and triplet lambs were more susceptible to hypothermia than singles.

IBAR/1984  R.S. WINDSOR, D.S. DURRANT and K.J. BURN
109 Avian Tuberculosis in Pigs/ _Mycobacterium intracellulare_ Infection in a breeding Herd

_The vet. Record, 1984, 114 (20) 497._

AUTHOR'S SUMMARY: Lymphadenitis of pigs caused by _Mycobacterium intracellulare_ is widely recognised in continental Europe but this is the first report of it in England. No disease was seen on the farm but condemnations of tissues and organs at the slaughterhouse were often more than 100 a week and in one week were in excess of 200. The loss was greater to the slaughterhouse than to the farmer because of the constant disruption to the production line. There was no evidence that diseased pigs performed less well than healthy pigs. _M intracellulare_ types 4 and 6 and _M xenopi_ were isolated from diseased pigs. The source of the infection was traced to the sawdust bedding supplied by a local sawmill set in the middle of a forest. Changing the bedding to straw halted the outbreak. From the sawdust _M avium_ types 1 and 4, _M fortuitum_ and _M intracellulare_ type 4 were isolated. The wildlife round the sawmill was investigated as a source of infection. Although _M intracellulare_ type 4 and _M avium_ were isolated from moles and a hedgehog, it was concluded that the wildlife was not involved. There was no evidence of pig to pig transmission.

IBAR/1984  R.T. SHARPE and A.M. LANGLEY
110 The effect of _Theileria annulata_ Infection on the Immune Response of Cattle to Foot-and-Mouth Disease

AUTHOR'S SUMMARY: The primary and secondary antibody responses to foot-and-mouth disease virus vaccine were examined in cattle acutely infected with *Theileria annulata* and in carrier animals. Infected groups of cattle showed a trend towards consistently lower antibody responses than uninfected control cattle after both primary and secondary vaccination, although the reduction was not statistically significant. On mitogenic stimulation, peripheral blood leucocytes from infected cattle showed a reduced uptake of $^3$H-thymidine at the time of peak infection.
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