TRYPANOSOMA VIVAX IN NIGERIAN GOATS: EFFECT OF CHEMOTHERAPY OF SERUM CONSTITUENTS OF RED SOKOTO BUCKS

By

A.U. KALU¹, O.A. IKWUEGBU², H.U. EDEGHERE³ and G. A. OGBONNAH²

¹ Veterinary and Livestock Studies Division, Nigerian Institute for Trypanosomiasis Research (N.I.T.R.), Vom.

² Biochemistry Division, National Veterinary Research Institute (NVRI), Vom.

³ Pathology Division, Nigerian Institute for Trypanosomiasis Research (N.I.T.R.), Kaduna.

(Received 5 July 1986; accepted for publication 10 January, 1988).

ABSTRACT

The effect of trypanosome infection on serum protein and electrolyte levels was studied in Red Sokoto goats inoculated with *Trypanosoma vivax* and treated, during the course of the infection, with Berenil (diminazene aceturate), Samorin (isometamidium chloride) and Novidium (homidium chloride).

During the infection total protein, albumin and albumin/globulin (A/G) ratio decreased significantly ($P < 0.05$) while the globulin fraction and calcium increased progressively. Chloride concentration was elevated by the third week post infection and, despite treatment, by the sixth week.

Untreated animals died within five to six weeks of patent infection showing terminal hypoproteinaemia of 23.6%. Treatment abolished trypanosomaemia within 48 hours and reversed the effect of the infection by the second or third week post drug administration. There were slight but insignificant differences in the levels of the parameters monitored in the different drug-treated groups. However, four weeks post treatment preinfection levels of total protein and albumin, were not achieved by Berenil nor was therapy associated with modulation of the calcium and chloride concentrations to preinfection levels.

Key Words: Goats, Chemotherapy, Serum, Trypanosomiasis, Protein, Electrolytes.

INTRODUCTION

African animal trypanosomiasis is a debilitating disease of livestock. In Nigeria the most important trypanosome species infecting ruminants is *Trypanosoma vivax*. There have been extensive studies on most aspects of

the disease caused by the organism in bovine hosts but reports of caprine and ovine infections are few. However, recent evidence shows that the disease is prevalent in small ruminants (Kalu and Agu, 1984), result in huge financial losses (Griffin and Allonby, 1979; Kalu and Edeghere, 1985) and that these

small stock may serve as reservoirs of infection to other domestic animals and man (Mahmoud and Elmalik, 1977; Scott *et al.*, 1983).

The physiological levels of enzymes and other biochemical constituents of Nigerian cattle (Oduye and Fasanmi, 1971; Saror and Coles, 1973; Coles, 1984; Gbodi and Chechet, 1981) and goats (Gorczyca *et al.*, 1959; Oduye and Adedevoh, 1976; Akerejola, 1977; Oduye, 1980) have been documented. Nevertheless studies on changes in serum/plasma constituents associated with disease states have rarely been reported (Garner, 1950; Kapu, 1975; Gbodi and Chechet, 1981). Data on the effect of trypanosomiasis on serum levels of biochemical parameters of the ruminant population are limited to the studies on plasma amino acid profiles in cattle (Isoun *et al.*, 1979). We report the serum levels of biochemical parameters in apparently healthy and *T. vivax*-infected Red Sokoto goats and the effects of trypanocides on these parameters during the course of the disease.

MATERIALS AND METHODS

Thirty Red Sokoto male goats aged between 1½ and 3½ years, were purchased from an open market in Jengre, Plateau State, housed in sheep/goat pens and fed Acha hay supplemented with concentrates. Water, salt licks and feed were provided *ad libitum*. The goats were checked for infection with trypanosomes and other blood parasites three times a week: blood collected by jugular puncture into Bijou bottles containing EDTA was subjected to microscopic examination by the wet film, Giemsa-stained thin and thick films and the hae-

matocrit centrifugation techniques. Clinical examinations were carried out weekly on all animals. Also during an acclimatization period of three months, the animals are routinely treated with an acaricide prophylactic doses of anthelmintics and long acting antibiotics (Embacycline LA, May & Baker, Dagenham, England).

The goats were divided into 5 groups of six animals each. Groups 2 to 5 animals were each infected by subcutaneous inoculation of 0.5–1.0 ml of donor goats blood containing approximately 1×10^5 *T. vivax* organisms. Animals in groups 3, 4 and 5 were treated with curative doses of dimazine aceturate (Berenil, 3.5 mg/kg), isometamidium chloride (Samorin, 1.0 mg/kg) and homidium chloride (Novidium, 1.0 mg/mg) respectively after four weeks of patent infection.

Blood samples collected weekly by jugular venipuncture into sterile universal bottles two weeks before infection, and throughout the course of the infection and treatment, were allowed to stand at room temperature for 3 hours, centrifuged at 3000g for 10 minutes and sera separated and stored at 20°C till analysed.

Albumin levels were determined by the bromocresol green method described by Doumas *et al.* (1971). Total protein was estimated by the Biuret method, while globulin and albumin/globulin (A/G) ratio were calculated (Coles 1974). Calcium concentration was measured by the cresolphthalein complexone technique (Varley, 1976) and the chloride was estimated as described by Schales and Schales (1941).

The data were subjected to students 't' test and, where appropriate, by regression analysis by the least square method. Unless where stated, the value

were regarded as statistically significant at the 95% level.

RESULTS

Serum proteins

The mean serum biochemical levels for all control animals during the ten-week study period were 73.4g per litre (g l^{-1}), 34.6g l^{-1} and 38.5g l^{-1} for total protein, albumin and globulin respectively. These were slightly higher, but not significantly different from the two week pre-experiment value for all the clinically healthy goats Fig. 1 shows that during the four week course of infection, total protein and albumin decreased significantly ($P < 0.01$) while globulin values increased. Changes in these parameters in the different treatment groups showed only slight differences: decreases ranged from 14.70 to 20.51% for total protein and 15.15 to 20.57% for albumin, while the increase in the globulin fraction ranged between 8.68% and 14.42%. The A/G ratio decreased from a preinfection level of 0.88 ± 0.32 to 0.27 ± 0.14 . Changes associated with A/G showed wider individual and group range than any other parameter.

In untreated animals there was a maximum decrease of 44.4% in albumin values and a terminal hypoproteinaemia (23.60%) by the sixth week post infection. Treatment with trypanocides reversed the changes associated with trypanosomaemia. Total protein and albumin values increased relative to the pretreatment levels while globulin decreased.

However values resulting from chemotherapy were not significantly different from pretreatment levels till the second week after treatment post infection levels of total protein and al-

bumin were either achieved or were not significantly different from pre-infection levels in the Samorin and Novidium treated groups. This was due to significant ($P < 0.01$) increases of these parameters over pretreatment values between the second and fourth weeks of drug administration

Changes in serum electrolytes.

Mean weekly serum calcium concentration ranged from 8.16 ± 0.78 to 10.49 ± 1.08 mmol per litre (mmol l^{-1}) during the study period in the control group and all the clinically healthy goats showed a mean level of 9.27 ± 0.48 mmol l^{-1} . Infection resulted in significant increases in calcium concentration between the second and third weeks. For most of the course of the infection, the concentration of this mineral was only slightly higher than the mean pre-infection value (Table 1). This finding was common to both the treated (3,4 and 5) and non-treated (2) groups, except that hypocalcemia was recorded prior to death. Besides, post treatment values for animals in groups 3 to 5 were lower than, but not significantly different from, those of controls or the preinfection values of groups 2 to 5.

Preinfection, a mean chloride level of 108.73 ± 3.27 mmol per litre was recorded in all animals. Weekly mean values for infected groups varied widely both during infection and following therapy. Significantly higher values were obtained only at the third and sixth week of infection and occurred in all but the control group (Table 1). Treatment did not modulate the changes in calcium and chloride levels in animals which had undergone a four-week infection. Also the trypanocide used did not affect the changes in serum chloride levels.

Table 1.

**WEEKLY SERUM ELECTROLYTE LEVELS IN RED SOKOTO
GOATS DURING THE COURSE OF *TRYPANOSOMA VIVAX*
INFECTION AND FOLLOWING TREATMENT* WITH TRYPANOCIDES.**

Group ^a of animals	Para meter (Mean±Se)	Weeks	Post	Infection						
		0	1	2	3	4	5	6	7	8
1	Calcium	9.29	8.92	10.05	3.38	9.84	10.49	8.99	8.16	8.76
	(mmol l ⁻¹)	±0.54	±1.25	±1.10	±0.54	±0.86	±1.08	±0.68	±0.78	±0.58
	Chloride	107.34	133.04	119.15	104.79	107.74	106.07	115.25	98.91	106.61
	(Mmol l ⁻¹)	±2.59	±3.22	±7.14	±8.25	±8.25	±10.78	±10.77	±3.38	±8.08
2.	Calcium	9.15	10.25	10.02	11.21	9.44	10.73	8.97	—	—
		±1.02	±0.98	±0.68	±1.26	±1.08	±1.40	±0.53	—	—
	Chloride	106.90	120.63	116.95	126.78	110.50	138.80	128.05	—	—
		±4.26	±10.34	±6.32	±8.62	±9.88	±14.09	±8.44		
3.	Calcium	9.46	9.38	10.82	10.00	9.73	9.88	8.96	9.16	8.66
		±1.07	±1.66	±1.54	±1.08	±1.08	±0.43	±1.42	±1.31	±0.95
	Chloride	108.08	105.51	117.57	121.75	107.91	125.87	137.00	111.87	110.69
		±3.35	±2.98	±5.04	±7.88	±4.96	±10.94	±9.82	±8.66	±4.84
4.	Calcium	9.01	10.55	10.48	12.55	9.26	9.08	8.96	9.15	8.87
		±0.53	±0.72	±1.13	±1.00	±0.83	±0.48	±1.42	±1.31	±3.01
	Chloride	14.54	103.96	119.37	124.86	125.88	137.28	113.44	122.81	111.68
		±9.83	±8.01	±9.83	±8.78	±10.53	±10.53	±8.69	±8.82	±10.23
5	Calcium	9.16	9.86	11.06	11.02	9.84	9.63	9.46	9.61	9.01
		±0.81	±1.38	±0.09	±0.84	±1.10	±1.10	±1.06	±0.89	±0.55
	Chloride	106.77	105.63	130.67	116.15	109.18	135.57	128.13	127.74	124.57
		±7.38	±9.78	±9.47	±11.66	±7.58	±11.04	±9.63	±8.64	±10.38

*All treatment instituted after the 4th week post infection

3. Infected, Berenil — treated.

a Groups 1. Non-infected non-treated controls.

4. Infected, Samorin — treated.

2. Infected, non-treated (most animals dead by 7th Week).

5. Infected, Novidium — treated.

± SE= Standard Error.

FIG.1. CHANGES IN SERUM TOTAL PROTEIN (A), ALBUMIN (B) AND GLOBULIN (C) OF RED SOKOTO GOATS INFECTED WITH *TRYPANOSOMA VIVAX*.

DISCUSSION

The concentration of serum components in clinically healthy Red Sokoto goats were similar to those reported for total protein, albumin and A/G ratio by Egbinike *et al* (1979), and for calcium and chloride levels by Coles (1974) and Akerejola (1977) in Nigerian goats. *T. vivax* infection in the animals resulted in fulminating parasitaemia and terminated fatally within six weeks. Consistently low levels of total protein and albumin during infection are in agreement with the findings in cattle suffering from trypanosome infections (Garner, 1950) and streptothricosis (Kapu, 1975; Gbodi and Chechet, 1981). On the other hand, Anosa and Isoun (1976) reported higher total protein values in sheep (but less in goats) infected with *T. vivax*. Also Valli *et al* (1980) did not find any changes in total plasma protein levels in neonatal calves infected with *T. congolense* though six month old calves infected with the same strain had significantly lower values than control animals. These differences would suggest that changes in protein constituents of animals undergoing trypanosome infections may be related to the level of parasitaemia and the susceptibility of the host to the infecting trypanosome species. Decreased total protein was due to the high level of albumin (Fig. 1). Decreased albumin concentration would, at least in part, be brought about by increased plasma volume similar to that reported in sheep (Clarkson, 1968) and be compensated for by increases in the α and β globulin fractions at different times during the course of the infection. This would result in total protein levels remaining constant as reported by Valli *et al* (1980).

Fiennes (1970) reported that calcium

levels were low at the time of relapse in calves infected with trypanosomes. Our results indicate that consistent increase in calcium levels occur in goats infected with *T. vivax* and that therapy is not accompanied by a return to preinfection levels. This would be supported by the fact that plasma calcium levels vary with the level of plasma proteins (Coles, 1974). Decreased protein levels during infection might have resulted in release of part of the protein-bound calcium. However this may not be the only mechanism involved in the changes in calcium concentration because (i). the lowest of plasma proteins post infection (4th week, Fig. 1) did not coincide with the highest increase in calcium level in serum and (ii) increases in total protein concentration following treatment were not accompanied by proportionate decreases in calcium electrolyte levels. Chloride levels have been reported to increase during relapse in bovine infections (Fiennes, 1970). However the relapse phenomena which occurred only in Berenil-treated caprine hosts may not be responsible for elevated chloride levels recorded in all infected animals.

ACKNOWLEDGEMENTS

Our thanks are due to Messrs F. Doro, M. Baah, M. Gyang for technical assistance and R. Okafor for typing the script. The approval of the Directors of NITR and NVRI to undertake this project and their permission to publish the results are gratefully acknowledged.

REFERENCES

- AKEREJOLA, O O. (1977). The levels of some biochemical components of goats in the Savannah zone of Nigeria. *Nig. J. Anim. Prod.* 4: 73-75.

- ANOSA, V.O. and ISOON, T.T. (1976). Serum proteins, blood and plasma volumes in experimental infections of sheep and goats *Trop. Anim. Hlth. Prod.* 8: 14-19.
- CLARKSON, M.J. (1968). Blood and plasma volumes in sheep infected with *Trypanosoma vivax*. *J. Comp. Path.* 78: 189-193.
- COLES, E.H. (1974). Veterinary Clinical Pathology. 2nd Ed. W.B. Saunders co., Philadelphia and London.
- DOUMAS, B.T. WATSON, W.A. and BIGGS, H.G. (1971). Albumin standards and measurement of serum albumin with bromocresol green. *Clin. Chim. Acta.* 31: 87-96.
- EGBUNIKE, G.N., JEYAKUMAR, L.H. and OBI, T.U. (1979). Genetic and diurnal variations in the serum protein profiles of yearling caprine males. *Nig. J. Anim. Prod.* 6: 33-37.
- FIENNES, R.N.T.W. (1970). Pathogenesis and pathology of animal trypanosomiasis. Ed. H.W. Mulligan. George Allen and Unwin/ODA London pp. 729-750.
- GARNER, R.J. (1950). Some observations on the statues of mineral nutrition of Nigerian cattle. *J. Comp. Path.* 60: 108-116.
- GBODI, T.A. and CHECHET, J.I. (1981). Some biochemical values in serum from normal and *Dermatophilus congolensis* (cutaneous streptothriosis) infected Friesian cattle *Nig. Vet. J.* 10: 56-61.
- GORCZYCA, L.R., and LIMON, K.M. (1959). Studies of goat serum proteins by paper electrophoresis. *Am. J. Vet. Res.* 20: 921-924.
- GRIFFIN, L. and ALLONBY, W.E. (1979). The economic effects of trypanosomiasis in sheep and goats in Kenya. *Trop. Anim. Hlth. Prod.* 11: 113-142.
- ISOON, T.T., ISOON, M.J. and ANOSA, V.O. (1979). Plasma free aminoacid profiles of cattle infected with *Trypanosoma vivax*. a preliminary report. *Nig. J. Anim. Prod.* 6: 94-96.
- KALU, A.U. and AGU, W.E. (1984). *Trypanosoma vivax* in Nigerian goats: preliminary report on the course of the disease in naturally acquired infection. *Proc. Nat. Conf. Dis. Ruminants. Nigeria NVRI*, Vom Oct -25 1984. pp. 186-189.
- KALU, A.U. and EDEGHERE, H.U. (1985). *Trypanosoma vivax* in Nigeria goats: economic effects of the infection. *Nig. J. Anim. prod.* 12(2): in press.
- KAPU, M.M. (1975). Mineral composition of serum form dermatophilus infected zebu cattle under grazing conditions in Nigeria. *Nig. J. Anim. prod.* 2: 247-251.
- MAHOUND, M.M. and ELMALIK, K.H. (1977). Trypanosomiasis: goats as a possible reservoir of *Trypanosoma Congolense* in the Republic of Sudan. *Trop. Anim. Hlth. prod.* 9: 167-170.
- ODUYE, O.O. (1980). Biochemical values in apparently normal Nigerian goats; electrophoresis of serum proteins. *Nig. Vet. J.* 9: No.2 21-23.
- ODUYE, O.O. and ADEDEVOH, B.K. (1976). Biochemical values in apparently healthy Nigerian goats. *Nig. Vet. J.* 5: 51-55.
- ODUYE, O.O. and FASANMI, (1971). Serum electrolyte and protein levels in the Nigerian white Fulani and N'dama breeds of cattle *Bull. epiz. Dis. Afr.* 19: 331-339.
- SAROR, D.I. and COLES, E.H. (1973). Some serum biochemical parameters in white Fulani (Zebu) and white Fulani/Friesian (cross bred) in Nigeria. *Bull. epiz. Dis. Afr.* 4: 489-493.

- SCHALES, O. and SCHALES, S.S. (1941). A simple and accurate method for the estimation of biological fluids. *J. Biol. Chem.* 140: 879-884.
- SCOTT, C.M., FREZIL, J.L., TROUDIC, A. and GODFREY, D.G. (1983). The sheep as a potential reservoir of human trypanosomiasis in the Republic of Congo. *Trans. roy. Soc. Trop. Med. Hyg.* 77: 397-401.
- VALLI, V.E.O., MILLS, J.N., LUMSDEN, J.H., RATTRAY, J.B. AND FORSBERG, C.M. (1980). The quantitation of *Trypanosoma congolense* in calves: ii. Biochemical changes. *Tropenmed. Parasitol.* 31: 288-298.
- VARLEY, H. (1976). Practical clinical Biochemistry 5th Ed. W. Heinemann Medical Books Ltd. New York.