

Correlation of physiological plasma lipid levels with resistance of cattle to trypanosomosis

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ABSTRACT

Haematological parameters and indices as well as plasma lipids (cholesterol and triglyceride) levels were studied in trypanotolerant N'Dama and trypanosusceptible White Fulani (Zebu) cattle raised in the same environment in order to determine the probable role of plasma lipids levels in the phenomenon of trypanotolerance in tropical cattle. The haematological parameters and indices, such as PCV, Hb concentration, RBC, WBC counts, MCV and MCH, showed no significant differences ($P > 0.05$) between the two cattle breeds or sex. N'Dama cattle had significantly lower levels of plasma cholesterol ($P < 0.05$) and triglycerides ($P < 0.01$) than Fulani cattle. Male N'Dama cattle had significantly higher plasma cholesterol levels than females. While no significant gender difference ($P > 0.05$) was observed in plasma triglyceride levels in N'Dama cattle, a significantly higher ($P < 0.012$) plasma triglyceride level was recorded in female White Fulani cattle than in their male counterparts. The findings in this study suggest a possible correlation between plasma lipid levels and trypanotolerance or susceptibility between N'Dama and White Fulani cattle. The roles of plasma lipids in trypanosome growth and differentiation, as well as in the pathology of the disease in the host, are discussed.

Key words: haematology, plasma lipids, cattle, trypanosomosis, trypanotolerance, Nigeria.

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Introduction

In Africa, certain breeds of cattle exhibit tolerance to trypanosomosis, while other breeds rapidly succumb to trypanosome infection (STEWART, 1951). According to FAO/ILCA (ANONYMOUS, 1980), the trypanotolerant breeds are N'Dama (*Bos taurus*), West African shorthorn (Muturu) and Keteku. On the other hand, Zebu (*Bos indicus*) cattle, such as the White Fulani and East and East African Boran cattle, are susceptible to the severe effects of trypanosome infections (ROBERTS and GRAY, 1973; PALING et al., 1991). It is known, however, that trypanosome is not an absolute trait. Trypanotolerance is associated with some distinct characteristics which are reported to be under polygenic control (WHITELAW et al., 1980; DOLAN, 1987), and can be affected by phenotypic conditions such as stress of intercurrent infections, degree of exposure to tsetse, trypanosome species and poor nutrition (MURRAY et al., 1982; CHANDRA, 1986), among others.

Lipids have special importance physiologically as the hydrophobic constituents of biologic membranes (BRETSCHER and RAFF, 1975) and as the most concentrated source of energy than any of the major foodstuffs (BARTLEY, 1989). Lipids, including cholesterol and triglycerides, are ubiquitous in body tissues and play important roles in virtually all aspects of biological life. They serve as hormones or hormone precursors, an aid to digestion, they provide energy storage and metabolic fuels, act as functional and structural components in biomembranes in man, animals and their parasites, and from insulation to allow nerve conduction or to prevent heat loss (STEIN, 1987).

Decreases in plasma levels of cholesterol and serum phospholipids have been reported in sheep infected with *Trypanosoma congolense* (KATUNGA-RWAKISHAYA et al., 1991) and in man infected with *T. brucei* (HUET et al., 1990). These have been attributed to the fact that trypanosomes take up lipids for growth in the infected host (KATUNGA-RWAKISHAYA et al., 1991). On the other hand, lipidaemia and hypertriglyceridaemia were reported in rabbits (GUY, 1975; BEUTLER and CERAMI, 1986) and in man (HUET et al., 1990) infected with *T. brucei*. The increase in serum triglyceride levels during trypanosomosis was attributed to the inhibitory effect of a cytokine, tumour necrosis factor- (TNF-) on lipoprotein lipase activity, thus causing disturbances in lipid metabolism and food digestion and absorption in the alimentary tract (BEUTLER and CERAMI, 1986).

The aim of this study was to compare and correlate the physiological levels of cholesterol and triglyceride in the plasma of clinically healthy male and female White Fulani and N'Dama cattle reared within the same

environment with their susceptibility or tolerance to trypanosome infection.

Materials and methods

Twenty adult N'Dama (10 female and 10 male) and 20 White Fulani (10 female and 10 male) cattle in good physical and clinical conditions were selected from a group of cattle at the Breeding Unit of the Teaching and Research Farm, University of Ibadan, Nigeria. Ten millilitres of blood from the jugular vein was collected from each animal in both groups into heparinized tubes. Routine haematology, consisting of the determination of packed cell volume (PCV), haemoglobin concentration (HB), and erythrocyte (RBC) and leucocyte (WBC) counts were carried out (JAIN, 1986) immediately after collection. Mean corpuscular volume and mean corpuscular haemoglobin were calculated (JAIN, 1986). The blood samples were later centrifuged at 1,200 G for 10 minutes at 37 °C and the plasma obtained. Determination of plasma triglyceride levels was carried out according to the methods of TORO and ACKERMANN (1975) and PESCE and BODOURIAN (1977), respectively.

Data obtained from the experimental animals were pooled and statistically analyzed using the student t test (ERICKSON and NOSANCHUK, 1982) for significant differences between breeds and sexes.

Results

Results of haematological parameters and indices and plasma cholesterol and triglyceride levels by breeds and by sex are shown in Table 1. There were no significant breed or sex differences ($P > 0.05$) in all the haematological parameters between N'Dama and White Fulani cattle. Significantly higher ($P < 0.01$) levels of cholesterol and triglycerides were observed in the plasma of White Fulani than in N'Dama cattle. Male N'Dama cattle had significantly higher ($P < 0.01$) plasma cholesterol levels than the females. In contrast, female White Fulani cattle had significantly higher ($P < 0.01$) plasma cholesterol level than their males. No significant gender difference ($P > 0.05$) in plasma triglyceride level was recorded in female White Fulani cattle than in their male counterparts.

Discussion

The results of this study showed similarities in the haematological parameters and indices of N'Dama and Zebu breeds of cattle. The results

are consistent with the findings of ODUYE and OKUNAIYA (1971). This study also revealed that the White Fulani, a trypanosusceptible Zebu cattle breed (IKEDE and TAIWO, 1985), had significant higher levels of plasma cholesterol and triglycerides than those of trypanotolerant N'Dama (taurine) cattle. The reasons for gender difference in the levels of plasma cholesterol and triglycerides in both breeds of cattle are not known. The higher lipid values observed in Zebu cattle may be due to a high lipid catabolic rate in adipose tissue and synthesis in the liver (BARTLEY, 1989). It may also be due to an inherent deficient lipid clearance rate from the blood, or a genetic deficiency of lipogenetic hormones, such as glucagons and adrenaline (HARDIE, 1980). Genetic deficiency of enzyme acetyl-CoA carboxylase (BARTLEY, 1989) or its phosphorylation and inactivation by glucagon and adrenaline, have also been reported to lead to high plasma lipid levels (HARDIE, 1980). On the other hand, the lower plasma lipid levels in the N'Dama cattle may be attributed to an inherent superior lipid clearance from the blood and a more active enzyme and hormonal control of lipid synthesis.

Table 1. Haematology and plasma lipids levels (mean±SE) in male and female N'Dama and White Fulani cattle in Nigeria

Cattle breed	Sex (N)	PCV (%)	Hb (g/dl)	RBC (10 ¹² /l)	MCV (fl)	MCHC (%)	Triglyceride (mMol/l)	Cholesterol (mMol/l)
N'Dama	F (10)	32.5±0.6	11.4±0.5	6.8±0.8	47.6±2.4	34.6±0.5	88.3±8.7**	62.3±5.5
	M (10)	31.5±0.7	10.2±0.5	6.4±0.6	50.4±3.2	32.1±0.8	117.0±8.0	66.0±8.1
	F & M	31.9±1.3	11.2±1.4	6.7±0.7	47.6±2.8	34.5±1.1	102.6±3.1 ^a	64.1±5.7 ^a
White Fulani	F (10)	31.5±1.0	6.9±0.6	10.5±0.8	45.7±2.6	33.3±0.3	128.3±1.0**	82.0±4.4*
	M (10)	34.0±2.4	7.1±0.8	11.6±0.5	47.9±1.9	33.6±0.9	113.0±1.1	70.0±1.4*
	F & M	32.6±2.5	7.0±0.7	10.9±0.4	46.6±2.5	33.2±1.3	122.0±0.5 ^a	77.2±4.6 ^a

N=number of animals; F=female; M=male;

Statistical differences by gender are depicted by superscripted * in the same column; (*=P<0.05; **=P<0.01); while breed differences are represented by superscripted alphabets in the same column (a=P<0.01).

Data with no superscripts along the same column are not significantly different (P>0.05).

Biological membranes are based on a lipid bilayer made up of phospholipids, neutral lipids (mainly cholesterol) and glycolipids (BRETSCHER and RAFF, 1975). Trypanosomes have been reported to take up cholesterol, phospholipids and total lipids (KATUNGA-RWAKISHAYA et al., 1991), for growth. They can also serve as sources of energy for trypanosome metabolism (BARTLEY, 1989). Specific proteins in the cytosol of cells have been reported to exchange phospholipids between the different and remodelling of cellular phospholipids through exchange with plasma lipids have been reported (BRETSCHER and RAFF, 1975). This

suggests that trypanosusceptible animals such as Zebu, with high plasma levels, could provide a more conducive environment in terms of abundant lipid nutrients than trypanotolerant N'Dama for the growth and differentiation of trypanosome parasitaemias by the Zebu during infection (MURRAY et al., 1984). On the contrary, the low plasma lipid values of the trypanotolerant N'Dama would suggest that this animal has limited lipid nutrients to support the growth of trypanosomes, hence the development of lower parasitaemia during infection (MURRAY et al., 1984).

While trypanosomes take up lipids for growth, dead and dying trypanosomes release into the plasma toxic metabolites of which free fatty acids (triglycerides) and proteases are known to be injurious to the host's erythrocytes (HUAN et al., 1975; TIZARD et al., 1979). A complex of trypanosome lipids, proteins and glycoproteins were eluted from the *in vitro* culture of *T. brucei* with peritoneal macrophages (SACKS et al., 1982). This complex caused *in vitro* polyclonal splenic B cell stimulation, early enhancement and subsequent suppression of antigen-specific B cell responses. The extracted lipid component of this complex, mixed with macrophages, and the suspension injected into normal mice, caused partial suppression of an anti-sheep erythrocyte antibody response which was less severe than that with intact organism or parasite membranes (SACKS et al., 1982). Thus, it can be said that some lipid species can inhibit primary anti-trypanosome antibody responses or be mitogenic to normal spleen cells (RYAN and SHINITZKY, 1979) leading to the production of parasite-non-specific polyclonal antibodies, immune complex disease, clonal exhaustion and immunosuppression (RICKMAN and COX, 1980, ASKONAS, 1985). Lipidaemia and hypertriglyceridaemia reported in rabbits (GUY, 1975; BEUTLER and CERAMI, 1986) and in man (HUET et al., 1990) infected with *T. brucei*. Hypertriglyceridaemia during trypanosomosis was attributed to the inhibitory effect of TNF- on lipoprotein lipase activity with resultant disturbances in lipid metabolism and clearance, food digestion and absorption and cachexia (BEUTLER and CERAMI, 1986). Hence, any animal with inherently high physiological plasma lipid levels will suffer the deleterious effect of TNF- .

When combined with an efficient and effective parasite-specific immune response (PINDER et al., 1988) and parasite clearance mechanism (KAMANGA-SOLLO et al., 1991), genetically lower levels of physiological plasma cholesterol and triglyceride could be used as biochemical markers in the assessment of N'Dama and Zebu cattle, and their crosses for trypanotolerance programmes.

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SAŽETAK

U N'Dama goveda otpornih i u bijelih Fulani (Zebu) goveda osjetljivih na tripanosomijazu, uzgojenih u istim uvjetima, utvrđivana je moguća uloga razine lipida plazme na pojavu tripanotolerancije u tropskih goveda. Istraživani su hematološki pokazatelji kao i razine lipida plazme (kolesterola i triglicerida). Hematološki pokazatelji kao hematokrit, koncentracija hemoglobina, broj crvenih i bijelih krvnih stanica, prosječni volumen stanica i prosječni hemoglobin u krvi nisu pokazivali značajnih razlika ($P > 0,05$) između dvije skupine goveda kao niti među spolovima. N'Dama goveda su imala značajno niže razine kolesterola u plazmi ($P < 0,05$) i triglicerida ($P < 0,01$) nego Fulani goveda. Muška N'Dama goveda su imala značajno više razine kolesterola u plazmi od ženskih goveda. Trigliceridi plazme u N'Dama goveda nisu pokazivali značajne razlike ($P > 0,05$) s obzirom na spol, dok su u ženskih Fulani goveda bili značajno viši ($P < 0,012$) nego u njihovih mužjaka. Rezultati ovih istraživanja upućuju na moguću povezanost razina lipida plazme i otpornosti ili neotpornosti prema tripanosomijazi između N'Dama i bijelih Fulani goveda. Razmatrana je uloga lipida plazme na rast i diferencijaciju tripanosoma, kao i na patologiju bolesti u domaćina.

Ključne riječi: hematologija, lipidi plazme, goveda, tripanosomijaza, tripanotolerancija, Nigerija
