

**BIOCHEMICAL BLOOD PROFILE OF ANGONI CATTLE IN MOZAMBIQUE**F. Otto<sup>1</sup>, F. Vilela<sup>2</sup>, M. Harun<sup>2</sup>, G. Taylor<sup>3</sup>, P. Baggasse<sup>4</sup> and E. Bogin<sup>5</sup>

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**Summary**

The normal reference values of serum proteins, metabolites and minerals of Angoni cattle in Angonia Mozambique and the effects of age, sex and physiological state were determined. These indigenous animals, which proved to be more adaptable to the harsh climatic conditions and common diseases, are relatively free genetically of the "imported genes" for better production from outside Africa. Eighty-four young and mature, males and females at different physiological states were used for this study. Blood was taken, transported to the analyzing laboratory, serum was obtained and analyzed in a "Cobas Bio" blood analyzer and specific electrodes.

The following analytes and parameters were analyzed: AST, ALT, ALP, CK, GGT, LDH, total serum proteins, albumin, globulin, albumin-globulin ratio, glucose, cholesterol, urea, creatinine, bilirubin, uric acid, calcium, inorganic phosphorus, calcium-phosphorus ratio, sodium, potassium, chloride and hematocrit. The values obtained were statistically analyzed, the mean and standard deviations were calculated and set as the reference values.

No significant differences were seen between the males and females. Significant differences however, were seen between young and mature animals. With lower ALP, calcium, calcium to phosphorus ratio, chlorine and potassium, and higher values total proteins, globulin and urea, in the mature animals.

Significant differences were also seen between pregnant, non-pregnant and lactating cows with ALP, LDH, glucose and calcium being the highest in the non-pregnant cows. In lactating cows globulin and cholesterol were the highest and albumin-to-globulin ratio was the lowest. Pregnant cows showed the highest hematocrit and the lowest potassium in comparison to the other groups.

Highly significant negative correlations were seen between age and ALP, glucose, potassium, and phosphorus and positive correlations were seen between age, globulin and total proteins. Significant correlations were also seen between body weight/age ratio to glucose, ALP, total proteins and phosphorus.

Some significant differences were also seen in the blood levels of various analytes in comparison to cattle in other countries, which are a result of genetic, climatic, nutritional and environmental conditions.

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\* **online version note:** All the tables are found at the bottom of the page, you may scroll there or click hyperlinks from the paragraphs they are presented.

**Introduction**

With the ever-increasing interest in indigenous livestock as a possible solution to increased efficiency of production in harsh conditions, several studies have been published on various livestock species in southern Africa (1,2,3,4).

Many of the indigenous breeds in southern Africa are giving way to the exotic and cross-breeds. This has led to a situation where European breeds (Friesian-Holstein, Guernsey, Jersey, Ayrshire, Gelbvieh, Hereford, Limousin, Simmental, South Devon and Sussex), African breeds (Afrikaner and Boran) and the Indo-

American Zebu (Brahman) are now predominant in East African livestock, The local indigenous breeds have been reduced to small herds.

The only cattle to receive serious consideration are the Nguni Sanga and the Afrikaner, both of them admittedly widespread and flourishing, while the Afrikaner in particular being the main ranching breed throughout southern Africa and the Nguni are becoming one of the most thoroughly researched breeds in the region and considered ripe for improvement.

The only Zebu types in Zambia, Malawi and Mozambique, are the Angoni with an isolated population in Madagascar (1,3). As in most of Africa, cattle are closely identified with tribes and most of the names are those of tribes rather than geographical areas, though they are often synonymous.

The Angoni are mainly African zebu and belong to the East African short-horned group, though their horns are of medium length and are well built. They are all-purpose cattle living in areas to the south and west of Lake Malawi, where there is a largely dry tropical environment with extensive grazing lands, with a short growing season, and almost surrounded by pockets of tsetse infested regions. They are fairly small (122-127/112-120 cm, 350-570/250-475 kg) for male and female respectively and like other zebu, have a variety of coat colors. It is more than likely that they have been crossed to some extent with Sanga types: The semi-pastoral Angoni people (who are traditional cattle owners and a mixture of Mamitic, Bantu and Bushman stock) lost most of their cattle to tsetse-borne diseases in the latter part of the nineteenth century and built up new herds by rustling from other tribes in typical cattle culture fashion. Their cattle are mainly used for milk and meat production as well as being bridewealth stock.

Most of southern Africa's grazing area is subject to periodic drought, seasonal dry periods, low-nutrition winter grazing, cattle diseases and other major environmental stress factors. Indigenous cattle have demonstrated their ability to survive in such conditions, yet, although it has been proved that exotic breeds are unable to cope, there has been a long history of the persistent large-scale use of unsuitable breeds. Today, the farmers of southern Africa are looking much more closely at the half-despised native cattle and realize that, though their productivity seems low, many have the potential for much higher yields given appropriate management and selective breeding from within the breed rather than crossbreeding.

Maule (2) noted that Angoni compared favorably with other more productive breeds like Barotse, Mashona, Afrikaner and Boran cattle in calving and weaning rates. Very few publications deal especially with reference to the Angoni in Mozambique, where the Angoni breed is primarily located in the district of Angonia, near the Malawi border. These indigenous animals proved to be more adaptable to the harsh climatic conditions and common diseases such as theileriosis, fascioliasis and gastrointestinal parasites (4). These animals have little or no mixed genes from cattle imported into Africa (4).

The objectives of the present study were to establish the normal blood composition and reference values in relation to the above mentioned acquired characteristics and to compare the blood profile with other African breeds and to learn about deficiencies and possible ways to improve their production.

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## Materials and Methods

**Animals:** Eighty-four young, less than 1 year and mature, (2 years and more) males and females at different physiological states (pregnant, non-pregnant and lactating) Angoni cattle were used for this study. The cattle was grazed on naturally growing grass and showed no clinical signs of disease.

**Blood** was taken from the jugular vein, allowed to clot, serum was obtained following a centrifugation at 600 g for 10 minutes, stored at 4-6°C and transported to the laboratory for analysis. Enzymes were analyzed within 48 hours from its withdrawal and the rest was kept frozen at -180°C until analyzed. Enzymes, metabolites, proteins and minerals were determined using "Cobas-Bio" blood analyzer (H. LaRoche, Switzerland) and electrolytes were determined using specific electrodes, according to methods described in table 1 (5-21).

**Statistics:** Means, standard deviations, degree of significance and correlations were done using the SPSS program (22).

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## Results

The means and standard deviations of enzymes, proteins, metabolites, minerals and electrolytes in the blood of healthy Angoni cattle in Mozambique Africa is given in table 2.

The values of the above blood analytes classified according to sex is shown in table 3. There were significant differences between female and male Angoni cattle with gamma-glutamyltransferase, potassium and glucose being higher in the male group, and urea and calcium to phosphorus ratio higher in the female group. No significant difference were seen in the rest of the measured analytes.

The levels of blood analytes divided according to age are shown in table 4. Significant differences between young and mature cattle were seen. The analytes, alkaline phosphatase, total calcium, albumin to globulin ratio, inorganic phosphate, potassium and chlorine were higher in the young group, while total proteins, globulin and urea were lower than in the mature group.

The levels of blood analytes in cows classified according to their lactation and/or physiological state are shown in table 5. Cows were divided into 3 groups: pregnant, non-pregnant and lactating cows. Significant differences were seen in the levels of alkaline phosphatase and lactic dehydrogenase (higher in non-pregnant cows), total proteins, (being the lowest in the non-pregnant group), globulin and cholesterol (highest in the lactating cows) and albumin to globulin ratio (lowest in the lactating cows), potassium (lowest) and hematocrit (highest in the pregnant cows).

**Table 1.** Methodologies and References for the Determinations of Blood Analytes

Analyte	Method	Reference
<b>ENZYMES</b>		
aspartate aminotransferase AST EC 2.6.11	spectrophotometric	5
alanine aminotransferase ALT EC 2.6.12	"	6
alkaline phosphatase ALP EC 3.1.3.1	"	7
creatine kinase CK 2.7.3.2	"	8
gamma glutamyltransferase GGT EC 2.3.2.2	"	9
lactic dehydrogenase LDH EC 1.1.1.27	"	10
<b>PROTEINS</b>		
total proteins	calorimetric	11
albumin		12
globulin	calculated	-
albumin-globulin ratio		-
<b>METABOLITES</b>		
glucose	spectrophotometric	13
cholesterol	"	14
urea	"	15
creatinine	"	16
bilirubine	"	17
uric acid	"	18
<b>MINERALS and ELECTROLYTES</b>		
calcium total	calorimetric	19
calcium/phosphorus	calculated	-
phosphorus-inorganic	calorimetric	20
sodium	specific electrode	21
potassium		21
chlorine		21
<b>HEMATOLOGY</b>		
Hematocrit	Centrifugation	

There were highly significant correlations between age and the enzyme alkaline phosphatase ( $r=-0.649$ ;  $p<0.001$ ), age and blood glucose ( $r=0.734$ ;  $p<0.001$ ), age and serum potassium ( $r=-0.538$ ;  $p<0.001$ ), age and serum inorganic phosphorus ( $r=-0.654$ ;  $p<0.001$ ), and age and serum total proteins ( $r=-0.577$ ;  $p<0.001$ ) (Table 6). In calculating the correlation and significance between the animals' weight gain, there was only one correlation with creatinine ( $r=-0.544$ ;  $p<0.001$ ). However, whenever the calculation was done with body weight

to age ratio and the various blood analytes, representing the entire life period, an in-between number of analytes showing significant correlation were seen with alkaline phosphatase, glucose, globulin and total proteins. ( $r=-0.548$ ;  $p<0.001$ ), ( $r=-0.723$ ;  $p<0.001$ ), ( $r=-0.531$ ;  $p<0.001$ ), ( $r=-0.505$ ;  $p<0.001$ ) respectively.

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## Discussion

The present communication describes the blood composition of the relatively genetically pure indigenous Angoni cattle in southern Africa, and compares it to other local mixed breed cattle. Furthermore, the blood profiles of subgroups divided according to age, sex and physiological state were established.

Nutritional deficiencies, metabolic disorders and diseases, can be detected by analysis and monitoring of blood and other body fluids (23-28), using clinical chemistry and clinical pathology procedures. This, however, requires the establishment of normal reference values. By definition, pathological values are considered as those deviating from the normal reference values (23,24). Evaluation and interpretation of the results obtained depend on the reference values for each animal species, in different regions and under existing environmental conditions.

Since the animals used in this study showed no clinical signs or pathological symptoms, they were considered "healthy" and the data obtained can serve as reference values for future use of these animals in veterinary medicine and animal production (23,24). The data given in this communication can serve as reference values for Angoni cattle grown in Mozambique and other African countries having similar climatic and nutritional conditions.

By dividing the animals according to sex, age and physiological status, the range of the reference values narrowed, thus making it more defined, leading to a more sensitive diagnosis (23).

Comparing the reference values of the Angoni cattle with other cattle showed higher blood levels of the enzymes CK, ALT, AST and LDH, indicating the more active muscle mass resulting from a greater and more active grazing and search for food (23-28). There were no significant differences in the blood concentrations of most analytes measured. Of interest is the fact that serum globulin levels were not much higher, especially since the region is fraught with many parasites and pathogens, which may lead to a chronic stimulation of the immune system and the production of gamma globulin. This data support the notion that Angoni cattle are naturally selected for resistance to existing pathogens and environmental conditions of the region.

Very small and insignificant variations between male and female Angoni cattle were seen in the levels of the various blood analytes. Differences were seen between young and mature animals. Among the enzymes measured only ALP showed a significant difference, being much higher in young animals. This difference is seen in other species and is the result of the faster growth rate in young animals, and leakage of the enzyme from the growing bones and intestines into the blood (23,24). The significant differences between young and mature Angoni cattle in serum proteins is due to longer exposure to the various antigens and pathogens and production of antibodies. The higher globulin concentrations led to higher total serum proteins and lower albumin to globulin ratio (23,24). Among the metabolites measured the only significant difference seen was in serum urea which was higher in the mature animals. This could be a result of the greater efficiency of converting nitrogenous substances to amino acids and proteins, leading to a faster growth rate in young animals. The reason for the significantly lower levels of calcium and potassium levels seen in mature Angoni is not clear. As for calcium, it may be a result of continuous suckling by the young cattle, calcium-rich milk and lactating by mature females losing calcium in the milk.

The physiological status of the cows significantly affected the serum levels of some blood constituents. Differences were seen in serum LDH, ALP, glucose and calcium, which were highest in the non-pregnant, non-lactating cows and total proteins which were the lowest in the 3 groups. Highest globulin and cholesterol levels were seen in the lactating cows. All these differences could be related to the differences in the animals metabolism, needs for milk production and metabolic changes related to the development of the fetus.

There were some interesting relationships between serum analytes. One was seen between serum glucose and ALP ( $r=0.8064$ ,  $p<0.01$ ) and is probably due to the fact that both ALP and glucose are higher in young animals (23,24). This also explains the negative correlation seen between glucose and age ( $r=-0.6840$ ,  $p<0.01$ ). The positive relationship between glucose and inorganic phosphate ( $r=0.7714$ ,  $p<0.01$ ), could be both nutritional and metabolic. Poor or insufficient nutrition can lead to both lower glucose and phosphate and vice versa. Metabolically, since these two analytes are interrelated via the phosphorylation of glucose, the

trend of both analytes is similar. Higher levels of metabolism leads to lower serum level of both analytes.

The general pattern of changes seen with aging was lower K (-0.5221;  $p < 0.01$ ), lower glucose (-0.6840;  $p < 0.01$ ), higher globulin (-0.5870;  $p < 0.01$ ), which could be due to longer time exposure to various antigens and pathogens which leads to greater production of globulin. Of interest is the observation that the greatest increase of globulin concentration took place during the first 3 years of life after which time it levels with only small and increases with time.

The number of animals used in the entire group and subgroups, although not very large was greater than the minimal number of 8 recommended for statistical evaluation and establishment of reference values (28).

In conclusion, the present communication describes the normal reference values of a unique cattle breed, characterized by relative low cross breeding with foreign cattle breeds and adapted to the existing environmental, nutritional and pathogenic exposures. These special conditions are expressed in the blood composition, which is somewhat different from that of cattle grown under different conditions.

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**Table 2.** Enzyme Activities and Concentrations of Proteins, Metabolites, Minerals, Electrolytes and Hematocrit in Blood of Angoni Cattle

Analyte	Activity/Concentration
<b>ENZYMES</b>	
alanine aminotransferase (U/l)	36.9±14.5
asparate aminotransferase (U/l)	84.1±18.1
Alkaline phosphatase (U/l)	261.9±157.3
Gamma glutamyltransferase (U/l)	17.5±8.9
Creatine kinase (U/l)	213.4±154.1

lactic dehydrogenase (U/l)	2322±359
<b>PROTEINS</b>	
total proteins (g/l)	77.0±3.6
Albumin (g/l)	39.3±3.0
Globulin (g/l)	39.5±7.4
Albumin-globulin ratio	1.1±0.3
<b>METABOLITES</b>	
Glucose (mol/l)	3.1±1.6
cholesterol (mol/l)	4.8±1.3
creatinine (µmol/l)	98.7±14.7
urea (mmol/l)	4.5±1.1
bilirubine (µmol/l)	2.7±1.4
uric acid (µmol/l)	53.3±14.5
<b>MINERALS and ELECTROLITES</b>	
total calcium (mmol/l)	2.1±0.3
Calcium/phosphorus	1.0±0.3
phosphorus-inorganic (µmol/l)	2.2±0.6
Sodium (meq/l)	144.3±3.6
Potassium (meq/l)	5.2±0.8
Chlorine (meq/l)	109.3±3.9
<b>Hematocrit</b> (%)	32.4±5.7

(N=84)

**Table 3.** Enzyme Activities and Concentrations of Proteins, Metabolites, Minerals, Electrolytes and Hematocrit in the Blood of Male vs. Female Angoni Cattle

Analyte	Sex	
	Female	Male
<b>ENZYMES</b>		
alanine aminotransferase (U/l)	37.0±8.6	36.9±14.5
aspartate aminotransferase (U/l)	83.2±15.0	36.9±14.5
Alkaline phosphatase (U/l)	241.8±142.6	84.1±18.1
Gamma glutamyltransferase (U/l)	17.5±8.9	261.9±157.3
Creatine kinase (U/l)	213.4±154.1	17.5±8.9
lactic dehydrogenase (U/l)	2322±359	213.4±154.1
<b>PROTEINS</b>		2322±359
total proteins (g/l)	77.0±3.6	
Albumin (g/l)	39.3±3.0	77.0±3.6
Globulin (g/l)	39.5±7.4	39.3±3.0
Albumin-globulin ratio	1.1±0.3	39.5±7.4
<b>METABOLITES</b>		1.1±0.3
Glucose (mol/l)	3.1±1.6	
cholesterol (mol/l)	4.8±1.3	3.1±1.6
creatinine (µmol/l)	98.7±14.7	4.8±1.3
urea (mmol/l)	4.5±1.1	98.7±14.7
bilirubine (µmol/l)	2.7±1.4	4.5±1.1
uric acid (µmol/l)	53.3±14.5	2.7±1.4
<b>MINERALS and ELECTROLITES</b>		53.3±14.5
total calcium (mmol/l)	2.1±0.3	
Calcium/phosphorus	1.0±0.3	2.1±0.3
phosphorus-inorganic (µmol/l)	2.2±0.6	1.0±0.3
Sodium (meq/l)	144.3±3.6	2.2±0.6
Potassium (meq/l)	5.2±0.8	144.3±3.6

Chlorine (meq/l)	109.3±3.9	5.2±0.8
<b>Hematocrit (%)</b>		109.3±3.9

N=14-35; p<0.05

**Table 4.** Enzyme Activities and Concentrations of Proteins, Metabolites, Minerals, Electrolytes and Hematocrit in the Blood of Young and Mature Angoni Cattle

Analyte	Age	
	Young	Mature
<b>ENZYMES</b>		
alanine aminotransferase (U/l)	36.3±10.0	37.8±8.1
aspartate aminotransferase (U/l)	81.5±20.1	84.1±18.1
Alkaline phosphatase (U/l)	305.8±166.9	160.7±58.0*
Gamma glutamyltransferase (U/l)	15.6±6.4	17.5±8.9
Creatine kinase (U/l)	246.8±181.2	213.5±154.1
lactic dehydrogenase (U/l)	2346±399	2322±357
<b>PROTEINS</b>		
total proteins (g/l)	72.6±9.7	83.8±7.5*
Albumin (g/l)	39.3±2.8	39.3±3.4
Globulin (g/l)	33.3±6.9	44.4±4.9*
Albumin-globulin ratio	1.2±0.3	0.9±0.2*
<b>METABOLITES</b>		
Glucose (mol/l)	3.8±1.6	1.9±0.6
cholesterol (mol/l)	4.6±1.1	5.0±1.6
creatinine (µmol/l)	98.1±11.3	99.6±19.7
urea (mmol/l)	4.1±1.1	5.0±0.8*
bilirubine (µmol/l)	2.6±1.4	3.0±1.6
uric acid (µmol/l)	51.7±15.9	55.4±14.5
<b>MINERALS and ELECTROLITES</b>		
total calcium (mmol/l)	2.2±0.2	2.0±0.2*
Calcium/phosphorus	0.9±0.3	1.2±0.4
phosphorus-inorganic (µmol/l)	2.5±0.6	1.9±0.4*
Sodium (meq/l)	145.1±2.3	143.2±4.7
Potassium (meq/l)	5.4±0.7	4.8±0.7*
Chlorine (meq/l)	110±2.6	107.3±5.0*
<b>Hematocrit (%)</b>	32.7±6.6	32.0±4.2

N=23-51 \*p<0.05

**Table 5.** Enzyme Activities and Concentrations of Proteins, Metabolites, Minerals, and Electrolytes in Serum of Pregnant, Non-pregnant and Lactating Angoni Cows

Analyte	Physiological State		
	Pregnant	Non-Pregnant	Lactating
<b>ENZYMES</b>			
alanine aminotransferase (U/l)	35.9±7.7	49.8±13.2	56.6±12.6
aspartate aminotransferase (U/l)	86.2±12.5	84.6±16.5	87.2±13.2
Alkaline phosphatase (U/l)	127±56.1	221.3±59.2*	137.9±54.1
Gamma glutamyltransferase (U/l)	15.3±1.7	14.6±7.1	17.4±3.2
Creatine kinase (U/l)	150±32	318±120	144±41
lactic dehydrogenase (U/l)	2020±124	2517±402*	2212±182
<b>PROTEINS</b>			
total proteins (g/l)	82.8±4.9	77.3±7.5*	85.0±8.7

Albumin (g/l)	42.3±2.2	39.3±1.6	39.4±2.8
Globulin (g/l)	40.5±3.6	39.3±4.8	44.3±4.6*
Albumin-globulin ratio	1.1±0.1	1.1±0.2	0.9±0.1*
<b>METABOLITES</b>			
Glucose (mol/l)	2.0±0.8	3.0±0.8*	1.6±0.5
cholesterol (mol/l)	4.3±1.5	4.5±0.9	5.6±1.7*
creatinine (µmol/l)	95.1±39.1	101.6±12.8	99.7±16.5
urea (mmol/l)	4.7±0.3	5.2±0.9	4.8±0.6
bilirubine (µmol/l)	2.9±2.2	2.1±0.9	3.1±1.3
uric acid (µmol/l)	47.2±7.7	49.5±18.2	56.6±12.6
<b>MINERALS and ELECTROLITES</b>			
total calcium (mmol/l)	2.1±0.2	2.3±0.3*	2.0±0.2
Calcium/phosphorus	1.3±0.3	1.1±0.2	1.2±0.5
phosphorus-inorganic (µmol/l)	1.7±0.3	2.1±0.3	1.9±0.5
Sodium (meq/l)	143.9±1.4	145.5±2.1	134.2±4.7
Potassium (meq/l)	4.2±0.2*	5.1±0.4	4.8±0.9
Chlorine (meq/l)	111.9±7.0	110.4±2.7*	106.4±4.3
<b>Hematocrit (%)</b>	36.8±5.5*	29.6±3.9	32.0±3.3

N=11-23 \*p<0.05

**Table 6.** Correlations Between Blood Analytes and Physiological Parameters (p<0.01 in all correlations).

<b>Correlation between</b>	<b>r</b>
Age and ALP	-0.649
Age and glucose	-0.734
Age and globulin	0.621
Age and potassium	-0.538
Age and phosphorus	-0.654
Age and Total proteins	0.577
Daily Weight gain and creatinine	0.544
Body weight/age and ALP	0.548
Body weight/age and glucose	0.723
Body weight/age and globulin	-0.531
Body weight/age and phosphorus	0.472
Body weight/age and cholesterol	-0.402
Body weight/age and Total proteins	0.505

N=39-84

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Plasma biochemical profiles were studied in 112 mature (3 to 5-year-old) healthy cattle comprised of 61 Thai indigenous and 51 Simmental x Brahman crossbred male and cyclic female cattle at Nongkwang (Central Thailand) Livestock Research and Breeding Center, Thailand. Data were analysed for the effect of breed and sex. 1984: Nutrient Requirement of Beef Cattle Blood profile of Paraguayan cattle in relation to nutrition, metabolic state, management and race. *Isr. J. Vet. Med.* 1992: Biochemical blood profile of Angoni cattle in Mozambique. *Article. Jan 2000. ISRAEL JOURNAL OF VETERINARY MEDICINE VOLUME 55 (3), 2000 BIOCHEMICAL BLOOD PROFILE OF ANGONI CATTLE IN MOZAMBIQUE* F. Otto<sup>1</sup>, F. Vilela<sup>2</sup>, M. Harun<sup>2</sup>, G. Taylor<sup>3</sup>, P. Baggasse<sup>4</sup> and E. Bogin<sup>5</sup> 1. Faculdade de Veterinária, UEM-C.P.257-Maputo-Mozambique 2. Estacao Zootecnica de Angonia-Tete-Mozambique 3. Department of Animal Science, Faculty. 4. Very few publications deal especially with reference to the Angoni in Mozambique, where the Angoni breed is primarily located in the district of Angonia, near the Malawi border. Anthelmintic resistance in nematodes of beef cattle in south-west Western Australia. *Veterinary Parasitology*. 207: 276-284. [5] Cruz BC, Lopez W, Maciel W, Felippelli G, et al. (2015). Susceptibility of *Rhipicephalus (Boophilus) microplus* to ivermectin (200, 500 and 630 µg/kg) in field studies in Brazil. *Veterinary Parasitology*. 207: 309-317. [6] Doornenbal H, Tong A and Murray N (1988). (2000). Biochemical blood profile of Angoni cattle in Mozambique. *Israel Journal of Veterinary Medicine*. 55(3). [21] Peter GG, Jackson P and Cockcroft D (2002). *Clinical Examination of Farm Animal*. Blackwell Science, 303-305. [22] Quintela L, Becerra J, Rey C, Díaz C, et al. Blood was taken, transported to the analyzing laboratory, serum was obtained and analyzed in a "Cobas Bio" blood analyzer and specific electrodes. The following analytes and parameters were analyzed: AST, ALT, ALP, CK, GGT, LDH, total serum proteins, albumin, globulin, albumin-globulin ratio, glucose, cholesterol, urea, creatinine, bilirubin, uric acid, calcium, inorganic phosphorus, calcium-phosphorus ratio, sodium, potassium, chloride and hematocrit. The values obtained were statistically analyzed, the mean and standard deviations were calculated and set as the reference values. The normal reference values of serum proteins, metabolites and minerals of Angoni cattle in Angonia Mozambique and the effects of age, sex and physiological state were determined.