



Effects of Breed, Sex, Age and Season on the Blood Biochemical Parameters of Sheep in Bauchi State, Nigeria

²Aliyu, N., ²Mbap, S. T. and ¹Boyi, B.

¹Department of Animal Science, Federal University Gashua, Yobe State, Nigeria

²Department of Animal Production, Abubakar Tafawa Balewa University, Bauchi.

Abstract

Blood biochemistry of indigenous sheep breeds in Bauchi, Nigeria was assessed. Blood samples were collected from one hundred and twenty sheep comprising Yankasa, Balami, Uda (32 per breed) and West Africa Dwarf (24) at the Abubakar Tafawa Balewa University Teaching and Research Farm, Muda Lawal, Durum and Gwallaga markets. Auto analyser was used for biochemical analyses. The results indicated that Uda had the highest values of sodium (136.34±0.59 mmol/L), urea (6.10±0.30 mmol/L), total protein (7.55±0.14 mmol/L), total cholesterol (4.12±0.25 mmol/L) and alkaline phosphate (109.97±3.01 mmol/L). Aspartate amino transferase (13.68±0.38 I μ /L) was higher in female sheep than in their male counterparts while the males had higher glucose value (5.07±0.16 mmol/L). Sodium (135±0.85 mm/L), TP (7.08±0.13 g/dl) and AP (106.81±2.16 g/dl) were higher in the dry season while those of CRT (106.21±1.93 mmol/L) and ALB (4.52±0.34 g/dl) were higher in wet season. However, the values of Na⁺ (135.00±0.59 mmol/L) and GLC (5.17±0.20 mmol/L) were higher in adult than in young. It was concluded that there were breed, sex, age and seasonal variations in biochemical parameters of the sheep breeds studied.

Key words: Blood, biochemistry, sheep, breed, sex, season

Introduction

In Nigeria, sheep contribute about 50% of the total domestically produced meat (FAO, 2007). Apart from provision of food and skin, sheep production plays a crucial role in socio-economic changes such as improvement in income and quality of life (Dagnachew *et al.*, 2011).

Sheep thrive in a wide variety of environments in the tropics and sub tropics and requires less capital as they can be completely maintained on pastures, browse and agricultural waste products (FAO, 2007).

Blood is the red fluid that circulates in veins and arteries. It is made up of the liquid, plasma, and various cells and, biochemicals (Tambuwal *et al.*, 2003; Abdel-Fattah *et al.*, 2013). The primary function of the blood is to

benjaminboyi51@gmail.com

+ 2348169145026, +2349062076686

transport oxygen from lungs to the body cells (Duke, 1975; Koubkova *et al.*, 2003), distribute nutrients and enzymes, carry away waste products and thereby maintain the homeostasis of the internal environment (Akinmutimi, 2004). Biochemical tests have been widely used for the diagnosis of disease and nutritional status of animals. Information gained from blood parameters substantiates physical examination and together with medical history provide the basis for judgment and decision making (Schalm, *et al.*, 1975; Cambell, 2007). In addition, it helps to determine the extent of tissue and organ damages and response of defence mechanism (Fantu *et al.*, 2012).

The blood is the life of an animal (Cambell, 2007). Blood constituents therefore determine their well-being. Differences in feeding habit including the type consumed, altitude and

other environmental factors affects blood biochemistry of animals and humans (Radostits *et al.*, 2000). The blood constituents of sheep in general have been fairly well studied in the developed world and also in some locations in Nigeria. There is however scant information from most parts of Nigeria; particularly the north east. In the Bauchi zone, work on this aspect is virtually non-existent. Since blood compositions vary due to different causes, extrapolation of information from elsewhere and from other species and breeds would hardly be meaningful. Studies have to be environment specific to be useful.

The objective of this study therefore, was to determine the effects of breed, sex, age and season on the biochemical parameters of indigenous sheep breeds in Bauchi.

Materials and Methods

Area of the Study

The study was conducted in Bauchi and environs between March and September. Samples were collected from Abubakar Tafawa Balewa University Teaching and Research Farm, Durum and Muda Lawal markets Bauchi for both dry (between November to May) and wet (between June to October) seasons. Bauchi State occupies 49,119 km² representing about 5.3% of Nigeria's land mass and it is located between latitude 10.314159, and longitude 9.846282. Bauchi, Nigeria is located within the GPS coordinates of 10° 18' 50.9724" N and 9° 50' 46.6152" E and at an altitude of 628m above sea level (Abubakar, 1974). It is bordered by seven states, Kano and Jigawa to the north, Taraba and Plateau to the south, Gombe and Yobe to the east and Kaduna to the west.

Climate and Vegetation

The rainfall in Bauchi state range between 1300 mm per annum in the south and only 700 mm in the extreme north (Muhammad, 2003).

The rains are usually due to the moisture laden south westerly winds. The rains therefore start earlier (April) in southern part of the state and vary to June and July in the northern areas. The average relative humidity, daily sunshine hours and temperature values range between 35 and 94 % for the months of February and August, 5.0 and 10.0 hours in August and November and 36.6 to 12.8^o C from April to December, respectively (Muhammad, 2003).

The soils are composed of ferruginous types on crystalline rocks, and, lithosol and juvenile formation on Aeolian sand (Areola, 1978). Bauchi state spans three vegetation zones, namely, northern guinea, Sudan and Sahel savannahs (Areola, 1978; Abubakar, 1974).

Market Sheep Management

Sheep brought to the market that were not sold immediately are tethered in shades or open environment with feeders and drinkers. Depending on the market situation they may remained for up to 1-2 weeks with dealers. The sheep are fed mostly with hay, cereal bran, cowpea husk or mixture. Scanty health management is practiced. In the events of an outbreak, sheep are slaughtered and sold at give-away prices.

Data Collection

Blood collection and Analyses

Seven millilitres (7 ml) of blood was collected from 120 sheep (32 each of Yankasa, Balami and Uda and, 24 WAD) for both dry and wet seasons. Sixteen (16) samples each in both sexes were collected from Yankasa, Balami and Uda while twelve (12) samples were collected from each of female and male WAD sheep breed. Similarly, fifty eight (58) and sixty two (62) samples were collected from young and adult sheep, respectively comprising sixteen (16) samples from each of adult and young Yankasa, Uda and Balami while ten (10) and fourteen (14) samples each from young and adult WAD. Sheep were

classified as young and adult by dentition according to (Isidahomen *et al.*, 2011).

The blood was collected using a hypodermic syringe through the jugular vein. The blood was delivered into dried appropriately labelled sterile test tubes with screw caps, kept slanted and allowed to clot. The blood samples were immediately transported to the Hematology Laboratory of Abubakar Tafawa Balewa University Teaching Hospital. The samples were left at room temperature for about 2 hours and then centrifuged at 10000 gravity for 5 minutes to yield sera. The sera were separated into clean labelled tubes and stored at -20° C until analyzed for biochemical constituents.

Preparation of serum samples

Whole blood sample was collected aseptically in to clean, dried and covered test tube and, allowed to clot by leaving it undisturbed at room temperature, for 15-30 minutes. The clot was removed by centrifugation at 1,000 – 2,000 x g for 10 minutes. The resulting supernatant (serum) was then carefully removed using a pasteur pipette (Henry, 1979). Total serum protein, aspartate amino transferase (AST), alanine amino transferase (ALT), alkaline phosphatase (ALP), urea (UR), creatinine (CRT), albumin (ALB), total cholesterol (TC), sodium (Na⁺), chloride (Cl⁻), hydrogen carbonate (HCO₃⁻) and potassium (K⁺) were determined using the Randox Test Kits according to the manufacturer's prescriptions (Sood *et al.*, 2009).

Determination of blood sugar

The blood sugar was determined using a glucometer (ACCU CHEK active serial no. GN: 10023338). The instrument was first charged before use. A single glucose stripe was later inserted into position and the glucometer allowed to zero. Immediately, blood sample was dropped onto the appropriate position on the glucose stripe and the instrument allowed few seconds to record.

The blood sugar was read only when the result on the glucometer remains steady for 2 seconds but not higher.

Data Analysis

Data generated were subjected to analysis of variance (ANOVA) using the general linear model (GLM) procedure of SPSS Inc. (2013). All two factors interactions were tested and only the significant ones were included in the final model. Significantly different means were compared using the Duncan Multiple Range Test (DMRT). The model utilized for ANOVA was as follows:

$$Y_{ijklm} = U + B_i + S_j + A_k + Sn_l + (BS)_{ij} + e_{ijklm}$$

Y_{ijklm} = Observation on dependent variables

U = Common Mean

B_i = effect of ith breed (Yankasa, Uda, Balami and WAD)

S_j = effect of jth sex (Male and female)

A_k = effect of kth age (Young and adult)

Sn_l = effect of lth season (Dry and wet)

(BS)_{ij} = interaction effect of ith breed and jth sex

e_{ijklm} = random error term

Results

Effect of Breed on Biochemical Parameters

Averages of biochemical parameters by breeds were as presented in Table 1. Sodium, Urea and total cholesterol significantly (P<0.05) varied with breed. Similarly, alkaline phosphate (P<0.01) and total protein (P<0.001) varied with breed. Non-significant influence of breed on potassium, chloride, hydrogen carbonate, creatinine, albumin, AST, ALT and glucose were however observed. Uda had the highest sodium (136.34 mmol/L), urea (6.10 mmol/L), total protein (7.55 g/dl), total cholesterol (4.12 mmol/L) and alkaline phosphate (109.97 g/dl) while the least Na⁺ (130.28 mmol/L) and TP (6.10 g/dl), UR (4.90 mmol/L) and AP (96.14 g/dl), and TC (3.40 mmol/L) values were observed in Balami, Yankasa and WAD, respectively.

Effect of Sex on Biochemical Parameters

Average biochemical parameters by sex are presented in Table 2. The AST and GLC significantly varied with sex ($P < 0.05$). Females had higher AST (13.68 μL) than males (12.60 μL) while GLC was higher in males (5.05 mmol/L) than females (4.38 mmol/L). However, the effect of sex on the other biochemical parameters was also non-significant.

Effect of Season on Biochemical Parameters

Average biochemical parameters by season are presented in Table 3. There was significant effect of season on Na^+ , and ALB ($P < 0.05$), CRT, TP and AP ($P < 0.01$). The Na^+ , TP and AP values (135.06 vs 132.04 mmol/L, 7.08 vs 6.38 g/dl and 106.81 vs 98.61 mmol/L respectively) were higher in the dry than rainy season. The K^+ , Cl^- , HCO_3^- , UR, AST, ALT, GLC and TC values were however not affected by season.

Effect of Age on Biochemical Parameters

The average biochemical parameters by age are shown in Table 4. The Na^+ ($P < 0.05$), UR, TP and GLC ($P < 0.01$) also varied with age. Adults had higher values 135.00 mmol/L, 5.82 mmol/L, 7.09 g/dl and 5.17 mmol/L respectively. Values of K^+ , Cl^- , HCO_3^- , CRT, ALB, AST, ALT, TC and AP were however not significantly different by age.

The Effect of Breed x Sex Interaction on Biochemical Parameters

Table 5 depicts breed x sex interaction effect on the biochemical parameters. There was significant breed x sex interaction on Chloride (Cl^-), AST, ALT, GLC ($P < 0.001$), CRT, TP, ALB, TC ($P < 0.01$), HCO_3^- and AP ($P < 0.05$). The female WAD had the highest Cl^- value (111.25 mmol/L) and the least was observed in Balami female (90.56 mmol/L). The other categories had comparable values. Similarly, HCO_3^- value was highest 27.56 mmol/L in WAD male, followed by 27.38, 27.06, 26.78, 26.75 and 26.19 mmol/L in Yankasa male,

Uda female, WAD female, Balami male and Yankasa female respectively. Balami female however, had the least HCO_3^- value of 24.16 mmol/L while the other categories had similar values. For CRT, WAD and Uda females had the highest values; 113.79 and 11.25 mmol/L respectively while the least value was recorded in Uda male (97.19 mmol/L). The highest value for TP however was recorded in Uda female (7.59 g/dl) while the least was observed in Balami male (5.56 g/dl). Yankasa female however, had the highest value for ALB (5.56 g/dl) and the least was recorded in Balami male (3.31 g/dl).

The AST value was highest 15.69 μL in Uda female, and least 11.09 μL in WAD male. Uda female on the other hand had the highest value recorded for ALT (11.63 μL) and the least was in WAD female (5.34 μL). The value of GLC was however least (2.87 mmol/L) in WAD female while those for the other categories were similar. Total cholesterol was highest in Uda female (4.63 mmol/L) and least in Balami female (3.46 mmol/L). Female WAD however, had the highest value for AP (117.06 mmol/L) while the least value was recorded in Yankasa female (90.63 mmol/L).

Discussion

Effect of Breed on Biochemical Parameters

The findings in this study that generally biochemical parameters differed among breeds with Uda exhibiting higher values for Na^+ and TP, TC and ALP while the least Na^+ and TP, UR and ALP, and TC were recorded in Balami, Yankasa and WAD respectively agrees with the report of Keneko *et al.* (2008) and Mbassa and Poulsen (2003). The differences between breeds may be due to intrinsic variations leading to physiological and hormonal deviations. This may further have effect on parameters.

Effect of Sex on Biochemical Parameters

The significant variation in the values of AST and GLC as influenced by sex with the former in favour of females and the latter males, is in agreement with the results of Njidda *et al.* (2013).

Effect of Season on Biochemical Parameters

The findings of Keser and Bilal (2008) that there were no significant variations in K⁺, Cl⁻, HCO₃⁻, UR, AST, ALT, GLT and TC with season is in congruence with results of the present study.

Effect of Age on Biochemical Parameter

The significant variation in Na⁺, UR, TP and GL in favour of adult sheep recorded in the present study is comparable with the findings of Shumaila *et al.* (2008) and Fantu *et al.*, (2012). The higher values in MCH, MCHC, and platelets, LYM, Na⁺, UR, TP and GL observed in this study suggest a well-developed immune system in adult sheep than in young which has similarly been reported by Njidda *et al.* (2013) that immune system in sheep increased with age.

Average Biochemical Parameters by Breed x Sex Interaction

In the present study that female WAD had higher values for Cl⁻, CRT and AP while WAD and Uda males and, Yankasa female had least (for Cl⁻, CRT and AP respectively) agrees with the report of Shumaila *et al.* (2012).

In general, that there was significant breed x sex effect on most of the blood parameters considered which means that interaction effect should not be neglected (it should always be considered). Blood parameters recorded in a population therefore should not be averaged across breed only, but by sex within breed.

Conclusions

From the results of this study, it can be concluded that; most of the biochemical

parameters were mostly affected by breeds and season. The values obtained for the biochemical parameters, generally falls within the normal ranges. The biochemical parameters were higher in Uda than the other breeds.

Rainy season exhibited higher biochemical parameters than the dry and they were also influenced by age in favour of adult sheep. It is better to assess blood parameter by sex within breed rather than by breed only.

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Table 1: Effect of breed on biochemical parameters of indigenous sheep breeds

Parameter No.	Overall 120	Balami 32	Yankasa 32	Uda 32	WAD 24	Level of sig.
Means±S.E						
Na ⁺	133.65±0.42	130.28±1.24 ^a	135.34±1.28 ^{bc}	136.34±0.59 ^c	132.29±1.73 ^{ab}	*
K ⁺	4.43±0.33	5.219±1.25	4.23±0.11	4.19±0.98	3.98±0.17	NS
Cl ⁻	95.12±0.55	92.59±1.11	97.03±1.30	95.78±0.72	95.04±2.73	NS
HCO ₃ ⁻	26.35±0.25	25.46±0.95	26.78±0.36	26.03±0.46	27.38±0.71	NS
UR	5.40±0.12	5.18±0.26 ^a	4.90±0.32 ^a	6.10±0.30 ^b	5.45±0.31 ^{ab}	*
CRT	102.69±0.89	100.06±2.43	102.72±3.19	104.16±2.81	104.29±2.59	NS
TP	6.75±0.08	6.10±0.20 ^a	6.65±0.19 ^a	7.55±0.14 ^b	6.69±0.38 ^a	***
ALB	4.08±0.07	3.88±0.26	4.72±0.57	4.02±0.13	3.59±0.17	NS
AST	13.10±0.22	12.94±0.54	13.03±0.46	13.56±0.63	12.79±0.60	NS
ALT	9.18±0.21	10.00±0.53	9.36±0.57	9.19±0.66	7.83±0.69	NS
GLC	4.75±0.09	4.39±0.20	4.78±0.33	5.33±0.37	4.41±0.32	NS
TC	3.66±0.06	3.62±0.14 ^b	3.45±0.15 ^a	4.12±0.25 ^b	3.40±0.12 ^a	*
AP	103.98±1.15	99.94±3.21 ^{ab}	96.14±2.83 ^a	109.97±3.01 ^c	106.83±2.68 ^{bc}	**

Na⁺ = Sodium ion (mmol/L)K⁺ = Potassium ion (mmol/L)Cl⁻ = Chloride ion (mmol/L)HCO₃⁻ = Hydroge carbonate ion (mmol/L)

UR = Urea ((mmol/L))

CRT = Creatinine (mmol/L)

TP = Total protein (g/dl)

ALB = Albumin (g/dl)

abc = means with different superscripts on the same row differ significantly (P < 0.05).

AST = Aspartate amino transferase (Iµ/L)

ALT = Alanine amino tranferase (Iµ/L)

GLC = Glucose (mmol/L)

TC = Total cholesterol (mmol/L)

AP = Alkaline phosphatase (g/dl)

* = p<0.05

** = P<0.01

NS = Non-significant

Table 2: Effect of sex on biochemical parameters of indigenous sheep breeds

Parameters	Overall	Female 62	Male 58	Level of Sig.
Means±S.E				
Na ⁺	133.65±0.42	133.84±1.02	133.48±0.81	NS
K ⁺	4.43±0.33	4.68±0.72	4.21±0.86	NS
Cl ⁻	95.12±0.55	95.75±1.06	94.56±1.06	NS
HCO ₃ ⁻	26.35±0.25	25.98±0.59	26.67±0.35	NS
UR	5.40±0.12	5.36±0.23	5.44±0.21	NS
CRT	102.69±0.89	104.70±2.36	100.94±1.59	NS
TP	6.75±0.08	6.77±0.16	6.73±0.18	NS
ALB	4.08±0.07	4.41±0.36	3.79±0.93	NS
AST	13.10±0.22	13.68±0.38 ^a	12.60±0.39 ^b	*
ALT	9.18±0.21	9.38±0.48	9.00±0.40	NS
GLC	4.75±0.09	4.38±0.24 ^b	5.07±0.16 ^a	*
TC	3.66±0.06	3.76±0.16	3.57±0.10	NS
AP	103.98±1.15	101.84±2.23	103.98±2.20	NS

Na⁺ = Sodium (mmol/L)K⁺ = Potassium ion (mmol/L)Cl⁻ = Chloride ion (mmol/L)HCO₃⁻ = Hydroge carbonate ion (mmol/L)

UR = Urea (mmol/L)

CRT = Creatinine (mmol/L)

TP = Total Protein (g/dl)

ab = means with different superscripts on the same row differ significantly (P < 0.05).

AST = Aspartate amino transferase (Iµ/L)

ALT = Alanine amino tranferase (Iµ/L)

GLC = Glucose (mmol/L)

TC = Total cholesterol (mmol/L)

AP = Alkaline phosphatase (mmol/L)

* = p<0.05

NS = Non-significant

ALB = Albumin (g/dl)

Table 3: Effect of season on biochemical parameters of indigenous sheep breeds

Parameter No.	Overall 120	Dry Season 60 Means±S.E	Rainy 60	Level of Sig.
Na ⁺	133.65±0.42	135.06±0.85 ^a	132.04±0.94 ^b	*
K ⁺	4.43±0.33	4.79±0.62	4.01±0.09	NS
Cl ⁻	95.12±0.55	94.56±1.03	95.75±1.90	NS
HCO ₃ ⁻	26.35±0.25	26.02±0.41	26.73±0.53	NS
UR	5.40±0.12	5.55±0.90	5.23±0.26	NS
CRT	102.69±0.89	99.17±1.90 ^b	106.21±1.93 ^a	**
TP	6.75±0.08	7.08±0.13 ^a	6.380±0.2 ^b	**
ALB	4.08±0.07	3.70±0.14 ^b	4.52±0.34 ^a	*
AST	13.10±0.22	13.09±0.31	13.11±0.48	NS
ALT	9.18±0.21	9.00±0.32	9.38±0.55	NS
GLC	4.75±0.09	5.00±0.21	4.47±0.18	NS
TC	3.66±0.06	3.63±0.12	3.71±0.15	NS
AP	103.98±1.15	106.81±2.16 ^a	98.61±2.13 ^b	**

Na⁺= Sodium (mmol/L)K⁺= Potassium ion (mmol/L)Cl⁻ = Chloride ion (mmol/L)HCO₃⁻= Hydroge carbonate ion (mmol/L)

UR = Urea (mmol/L)

CRT = Creatinine (mmol/L)

AST = Aspartate amino transferase (Iμ/L)

ALT = Alanine amino tranferase (Iμ/L)

GLC = Glucose (mmol/L)

TC = Total cholesterol (mmol/L)

AP = Alkaline phosphatase (mmol/L)

* = P<0.05

ALB = Albumin (g/dl)

NS = Non-significant

TP = Total Protein (g/dl)

** =P<0.01

ab = means with different superscripts on the same row differ significantly (P < 0.05).

Table 4: Effect of age on biochemical parameters of indigenous sheep

Parameter No.	Overall 120	Young 58 Means±S.E	Adult 62	Level of Sig.
Na ⁺	133.65±0.42	132.30±1.12 ^b	135.00±0.59 ^a	*
K ⁺	4.43±0.33	4.81±0.67	4.05±0.08	NS
Cl ⁻	95.12±0.55	94.27±1.22	95.97±0.86	NS
HCO ₃ ⁻	26.35±0.25	26.58±0.521	26.12±0.39	NS
UR	5.40±0.12	4.99±0.18 ^b	5.82±0.23 ^a	**
CRT	102.69±0.89	100.67±2.04	104.72±1.89	NS
TP	6.75±0.08	6.41±0.16 ^b	7.09±0.17 ^a	**
ALB	4.08±0.07	4.40±0.34	3.77±0.09	NS
AST	13.10±0.22	13.30±0.43	12.90±0.55	NS
ALT	9.18±0.21	9.37±0.45	8.98±0.43	NS
GLC	4.75±0.09	4.33±0.20 ^b	5.17±0.20 ^a	**
TC	3.66±0.06	3.61±0.11	3.72±0.14	NS
AP	103.98±1.15	103.73±1.96	102.23±2.45	NS

Na⁺= Sodium (mmol/L)K⁺= Potassium ion (mmol/L)Cl⁻ = Chloride ion (mmol/L)HCO₃⁻= Hydroge carbonate ion (mmol/L)

UR = Urea (mmol/L)

CRT = Creatinine (mmol/L)

TP = Total Protein (g/dl)

NS = Non-significant

ALB = Albumin (g/dl)

ab= means with different superscripts on the same row differ significantly (P < 0.05).

AST = Aspartate amino transferase (Iμ/L)

ALT = Alanine amino tranferase (Iμ/L)

GLC = Glucose (mmol/L)

TC = Total cholesterol (mmol/L)

AP = Alkaline phosphatase (mmol/L)

* = P<0.05

** =P<0.01

Table 5: Breed x sex interaction effect on biochemical parameters of indigenous sheep breeds

	Cl ⁻		HCO ₃ ⁻		CRT		TP		ALB		AST		ALT		GLC		TC		AP		
	X	Se	X	Se	X	Se	X	Se	X	Se	X	Se	X	Se	X	Se	X	Se	X	Se	
Overall	95.12 ± 0.55	26.35 ± 0.25	102.70 ± 0.89	6.75 ± 0.1	4.08 ± 0.07	13.10 ± 0.2	9.18 ± 0.21	4.75 ± 0.10	3.66 ± 0.06	102.98 ± 1.15											
Balami (F)	90.56 ± 1.67 ^c	24.16 ± 0.84 ^c	101.19 ± 3.20 ^b	6.63 ± 0.2 ^b	4.44 ± 0.39 ^{ab}	13.19 ± 0.6 ^b	9.69 ± 0.67 ^b	3.98 ± 0.30 ^a	3.46 ± 0.20 ^b	101.75 ± 3.24 ^b											
Balami (M)	94.63 ± 1.67 ^b	26.75 ± 0.8 ^b	98.94 ± 3.20 ^c	5.56 ± 0.2 ^c	3.31 ± 0.39 ^c	12.69 ± 0.64 ^c	10.31 ± 0.67 ^a	4.80 ± 0.30 ^a	3.78 ± 0.20 ^a	98.13 ± 3.24 ^c											
Yankasa (F)	96.75 ± 1.67 ^b	26.19 ± 0.84 ^a	97.94 ± 3.20 ^c	6.18 ± 0.2 ^b	5.77 ± 0.39 ^a	12.88 ± 0.6 ^{bc}	7.96 ± 0.67 ^c	4.26 ± 0.30 ^a	3.49 ± 0.20 ^a	90.63 ± 3.24 ^c											
Yankasa (M)	97.31 ± 1.67 ^b	27.38 ± 0.84 ^a	107.50 ± 3.20 ^b	7.11 ± 0.2 ^a	3.66 ± 0.39 ^c	13.19 ± 0.6 ^b	10.75 ± 0.67 ^a	5.31 ± 0.30 ^a	3.42 ± 0.20 ^a	101.69 ± 3.24 ^b											
Uda (F)	95.19 ± 1.67 ^b	27.06 ± 0.84 ^a	111.25 ± 3.20 ^a	7.59 ± 0.2 ^a	3.72 ± 0.39 ^c	15.69 ± 0.64 ^a	11.63 ± 0.67 ^a	5.73 ± 0.30 ^a	4.63 ± 0.20 ^a	109.00 ± 3.24 ^b											
Uda (M)	96.38 ± 1.67 ^b	25.00 ± 0.84 ^{bc}	97.19 ± 3.20 ^c	7.52 ± 0.2 ^a	4.33 ± 0.39 ^{ab}	11.44 ± 0.64 ^c	6.75 ± 0.67 ^d	4.94 ± 0.30 ^a	3.61 ± 0.20 ^a	110.94 ± 3.24 ^a											
WAD (F)	111.25 ± 3.0 ^a	26.78 ± 1.6 ^b	113.79 ± 6.13 ^a	6.36 ± 0.5 ^b	4.04 ± 0.74 ^{ab}	11.09 ± 1.22 ^c	5.34 ± 1.29 ^{de}	2.87 ± 0.57 ^b	2.95 ± 0.39 ^b	117.06 ± 6.21 ^a											
WAD (M)	89.94 ± 1.67 ^c	27.56 ± 0.84 ^a	100.12 ± 3.20 ^b	6.75 ± 0.2 ^b	3.87 ± 0.39 ^c	13.06 ± 0.64 ^b	8.19 ± 0.67 ^c	5.23 ± 0.30 ^a	3.49 ± 0.20 ^b	105.19 ± 3.24 ^b											
Level of sig.	***	*	**	**	**	***	***	***	**	***	***	***	***	***	**	*					

AST = Aspartate amino transferase (Iu/L)

Cl⁻ = Chloride ion (mmol/L)HCO₃⁻ = Hydrogen carbonate ion (mmol/L)

AP = Alkaline phosphatase (mmol/L)

TP = Total Protein (g/dl)

abc = means with different superscripts on the same column differ significantly (P < 0.05)

ALT = Alanine amino transferase (Iu/L)

GLC = Glucose (mmol/L)

TC = Total cholesterol (mmol/L)

CRT = Creatinine (mmol/L)

ALB = Albumin (g/dl)

abc = means with different superscripts on the same column differ significantly (P < 0.05)

* = P<0.05

** = P<0.01

*** = p<0.001