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Original article

Haematological and serum biochemical responses of Jersey and three indigenous cow breeds at two physiological states in a humid tropical environment

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ABSTRACT

Twenty cows of four different breeds (Jersey (4), N'Dama (4), White Fulani (4) and Sokoto Gudali (8)) were used to assess their haematological and serum biochemical responses at two different physiological states. At dry (pre-gestation) phase, haemoglobin (Hb) concentration, Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin Concentration (MCHC), neutrophils, monocytes and eosinophils were not significantly different among the breeds. However, Packed cell volume (PCV) of N'Dama was significantly ($P<0.05$) lower than White Fulani but not significantly different from Jersey and Sokoto Gudali. Erythrocytes count of Jersey breed was not significantly different from White Fulani and Sokoto Gudali but significantly ($P<0.05$) lower than N'Dama. Platelet counts of Jersey, N'Dama and Sokoto Gudali were significantly ($P<0.05$) lower than the White Fulani breed. Leukocytes count in Jersey was not significantly different from that of N'Dama but it was significantly ($P<0.05$) higher than that of White Fulani and Sokoto Gudali breeds. Lymphocytes count of Jersey, White Fulani and Sokoto Gudali were identical but significantly ($P<0.05$) lower than that of N'Dama breed. Serum biochemical variables were not significantly influenced by the breeds except glucose, total protein and globulin. Serum glucose was higher

in White Fulani and Sokoto Gudali than Jersey and N'Dama breeds. Total protein was also lower in Jersey than other breeds. Identical globulin concentration was observed between Jersey and White Fulani, N'Dama and Sokoto Gudali. At gestation, all haematological parameters were significantly (P<0.05) influenced by the breeds except MCH, MCHC, neutrophils, monocytes and basophils. The PCV was significantly (P<0.05) higher in N'Dama than other breeds and erythrocytes was lower in Sokoto Gudali than other breeds. Haemoglobin concentration in White Fulani was not significantly different from Jersey and N'Dama but lower (P<0.05) than that of Sokoto Gudali breed. Platelets count of White Fulani was identical with Sokoto Gudali and Jersey but higher (P<0.05) than N'Dama. Leukocytes count was higher in Jersey and Sokoto Gudali than N'Dama and White Fulani while lymphocytes count was least in Sokoto Gudali breed.

1. Introduction

Blood acts as a pathological reflector of the status of exposed animals to toxicants and other conditions. The examination of blood provides the opportunity to clinically investigate the presence of metabolites and other constituents in the body of animals and it plays a vital role in the physiological, nutritional and pathological status of an animal (Aderemi, 2004). Blood constituents change in relation to the physiological status of an animal. These changes are important in assessing the response of farm animals to various physiological situations. These changes are often caused by several factors; some of which are genetic and others, non-genetic. Age, sex, breed and management systems are among the factors that influence blood-based parameters of farm animals. Haematology refers to the study of the numbers and morphology of the cellular elements of the blood – the red cells (erythrocytes), white cells (leukocytes), and the platelets (thrombocytes) and the use of these results in the diagnosis and monitoring of disease (Merck Manual, 2012). Haemtological studies are useful in the diagnosis of many diseases as well as investigation of the extent of damage to blood (Togun et al., 2007). Haematological studies are of ecological and physiological interest in helping to understand the relationship of blood characteristics to the environment (Ovuru and Ekweozor, 2004) and so could be useful in the selection of animals that are genetically resistant to certain diseases and environmental conditions (Isaac et al., 2013). They are good indicators of the physiological status of animals (Khan and Zafar, 2005) because of their relationship with the blood and blood forming organs (Bamishaiye et al., 2009). Isaac et al. (2013) observed that animals with good blood compositions are likely to show good performance. Laboratory tests on the blood are vital tools that help detect any deviation from normal in the animal or human body (Ogunbajo et al ., 2009). According to Olafadehan et al. (2010) examining blood for their constituents can provide important information for the diagnosis and prognosis of diseases in animals. Blood constituents change in relation to the physiological conditions of health (Togun et al., 2007). These changes are valuable in assessing response of animals to various physiological situations (Khan and Zafar, 2005). According to Afolabi et al. (2010), changes in haematological parameters are often used to determine stresses due to environmental, nutritional and/or pathological factors. Blood serum constituents reflect the metabolic status of the animal and are frequently used to assess the reproductive and productive performance of the farm animals. The importance of determining the haematological and biochemical indices of domestic animals have been well documented (Opara et al., 2006). Haematological and biochemical values of blood can provide baseline information and help in realistic evaluation of management practice, nutritional and physiological status of animals and diagnosis of health conditions. This study examined the effect of breed and physiological state on the haematological and serum biochemical response of Jersey and some cows reared under similar conditions in a humid tropical environment.

2. Materials and methods

2.1. Animal management and experimental site

The study was carried out at the Dairy Unit of the Teaching and Research Farm, University of Ibadan, Ibadan, Nigeria. The cows totaling 20 with ages ranging from 2.0-2.5 years with weight range of 270-315kg were housed under similar conditions and provided same feed for a period of 5 months. The animals were randomly allotted into four treatments on breed basis: Jersey, N'Dama, White Fulani and Sokoto Gudali cows respectively.

2.2. Blood sample collection

Blood samples were collected aseptically from jugular vein of each cow at the two different physiological stages (Pre-gestation and gestation) in the morning before grazing. Approximately 2ml blood was collected in heparinised vacuutainers for haematological studies while another 4 ml was collected in sterile vacuutainers. The samples in sterile vacuutainers were allowed to clot at room temperature and centrifuged at 3000rpm for 5 minutes for biochemical studies.

2.3. Blood sample analysis

Blood samples with anticoagulant were used for haematological analysis for packed cell volume (PCV), haemoglobin (Hb) concentration, red blood cells (RBC), mean cell volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), platelets, white blood cells (WBC), lymphocytes, neutrophils, monocytes and eosinophils determination as described by Feldman et al. (2000). Biuret method of serum total protein determination was employed as described by Kohn and Allen (1995). Albumin was determined using Bromcresol Green (BCG) method as described by Peter et al. (1982). The globulin concentration was obtained by subtracting albumin values from the total protein while the albumin/globulin ratio was obtained by dividing the albumin value by the calculated globulin value. Alanine amino transferase and Aspartate amino transferase activity were determined using spectrophotometric method with their respective kits.

2.4. Data analysis

All data obtained were subjected to analysis of variance in a completely randomized design using general linear model of SAS (1999). Treatments means were separated using Duncan's Multiple Range Test (DMRT) of the same software.

3. Results and discussion

The haematological parameters of Jersey and some indigenous cows at the pre-gestation phase are presented in Table 1. The PCV of the various cow breeds was within the normal physiological range for cows (24-46%) as reported by Mitruka and Rawnsley (1977). The PCV in N'Dama cows (34.50%) was not significantly different from that in Jersey and Sokoto Gudali but was significantly ($P<0.05$) higher than in White Fulani cows (28.50%). There was no significant difference in haemoglobin concentration among the cow breeds and all the values were within the normal physiological range (8-15g/dL) as reported by Mitruka and Rawnsley (1977). This is an indication that all the breeds had sufficient oxygen carrying capacity in their blood. A reduced red blood cell count implies a reduction in the level of oxygen that would be carried to the tissues as well as the level of carbon dioxide returned to the lungs (Soetan et al., 2013). The red blood cells count ($x10^6$/µl) of N'dama cows (5.76) was not significantly different from White Fulani and Sokoto Gudali but was significantly ($P<0.05$) higher than Jersey cows (4.76). This suggests that N'Dama is truly a trypanotolerant cow breed well adapted to this climatic zone as established in previous findings (Logan et al., 1989; Akinbamijo et al., 1998). The Mean Corpuscular Volume and Mean Corpuscular Haemoglobin Concentration were both within the normal physiological range in cows as reported by Latimer et al. (2003). Blood platelets are implicated in blood clotting; however, normal platelet counts do not guarantee their adequate function as there could be dysfunctions (Rao, 1983). A low platelet concentration suggests that the process of clot-formation (blood clotting) will be prolonged resulting in excessive loss of blood in the case of injury. The platelet counts ($x10^3$/µL) for Jersey (85.5), N'Dama (87.0) and Sokoto Gudali (92.75) cows were lower than the lower limit of the physiological range of platelets ($175x10^3$/µL) for normal cows as reported by Mitruka and Rawnsley (1977). It implies that only White Fulani cows were well positioned against thrombocytopenia and thrombasthenia (Maton et al., 1993), a disease of the platelets due to the reduction in their number and function respectively. Leukocytes ($x10^3$/µl) count for Jersey cows (9.20) were significantly higher than

those of White Fulani (6.86) and Sokoto Gudali (6.96). Leukocytes are cells of the immune system involved in defending the body against both infectious disease and foreign materials. The major functions of the white blood cell and its differentials (neutrophils, eosinophils, monocytes, basophils and lymphocytes) are to fight infections, defend the body by phagocytosis against invasion by foreign organisms and to produce or at least transport and distribute antibodies in immune response. Thus, animals with low white blood cells are exposed to high risk of disease infection, while those with high counts are capable of generating antibodies in the process of phagocytosis and have high degree of resistance to diseases (Soetan et al., 2013). They also enhance adaptability to local environments and disease-prevalent conditions. Since there was no significant difference in leukocyte differentials with the exception of lymphocytes and they were within normal physiological range for cows, no known disease condition was responsible for the difference. It is possible that the trypanotolerant nature of N'Dama cows was responsible for the high lymphocytes secretion which was perhaps involved in antibodies production from the B cells. Lymphocyte count (%) for Jersey (70.75) and N'Dama cows (77.75) was slightly higher than the normal physiological range (47.7-68.5%) as reported by Latimer et al. (2003). Excess amount of these leukocyte differentials may be indicative of disease infections or other challenges in the animals that necessitate their action and excess production. However, the values for the breeds under study were only slightly higher. So, they might not be infection laden but some other causes yet unknown could have accounted for such occurrence. In a joint study, Cork and Halliwell (2002) found the normal range for cows' lymphocyte to be between (45-75%). The increase may therefore not be surprising as there are laboratory variations for normal blood parameters (Latimer et al., 2003). Haematological parameters of N'Dama cows were found to be the closest to the normal physiological range at the pre-gestating phase.

Table 1
Haematological parameters of different breeds of dry cows before gestation.

Parameters	Jersey	N'Dama	White Fulani	Sokoto Gudali
Packed cell volume (%)	30.00±0.41^{ab}	34.50±2.02^{a}	28.50±1.94^{b}	31.00±1.08^{ab}
Haemoglobin (g/dL)	9.50±0.37	9.450±0.77	10.02±0.62	9.95±0.57
Erythrocytes (x10^{6}/µL)	4.76±0.19^{b}	5.76±0. 37^{a}	5.34±0.29^{ab}	5.22±0.25^{ab}
MCV (fL)	60.30±2.36	59.90±2.14	53.40±2.01	59.48±2.09
MCH (pg)	19.96±1.26	16.41±0.97	18.76±0.89	19.06±1.25
MCHC (g/dL)	31.67±2.06	27.39±2.13	35.16±1.97	32.10±1.76
Platelets (x10^{3}/µL)	85.50±10.36^{b}	87.00±5.10^{b}	147.00±25.10^{a}	92.75±5.12^{b}
Leukocytes (x10^{3}/µL)	9.20±1.07^{a}	8.55±0.40^{ab}	6.86±0.65^{b}	6.96±0.27^{b}
Lymphocytes (%)	70.75±1.11^{b}	77.75±2.02^{a}	66.00±2.74^{b}	68.00±2.04^{b}
Neutrophils (%)	24.00±1.87	22.75±3.17	24.75±3.28	23.50±4.7
Monocytes (%)	1.75±0.25	1.25±0.48	1.75±0.75	1.50±0.87
Eosinophils (%)	3.50±0.87	4.25±0.85	4.25±0.85	5.50±2.53

ab : Means on same row with different superscripts are significantly different (P<0.05)
SEM- Standard Error of means; fl- Femtolitre; pg- Picogram; MCV-Mean Corpuscular Volume
MCH-Mean Corpuscular Haemoglobin; MCHC-Mean Corpuscular Haemoglobin Concentration.

The serum biochemical variables of Jersey and other indigenous cows are presented in Table 2. Blood glucose is an important source of energy for many cells. Blood glucose is normally maintained by the breakdown of dietary carbohydrates and a rather complex system of endogenous production. Endogenous production results from glycogenolysis and gluconeogenesis. The maintenance of normal plasma glucose requires delicate balance of glucose availability with glucose utilisation. The glucose value for the respective cow breeds was within the normal physiological range (42-75 mg/dL) as reported by Latimer et al. (2003). Almost all proteins in the serum are produced by the liver. Immunoglobulins are the notable exception and they are produced by lymphoid tissue. Serum proteins are relatively short-lived with most having half-lives of about 10 days. The breakdown of these proteins occurs mostly in the liver with some catabolic activity in the intestine and kidney. Animal plasma normally contains 25-35 g/L of albumin which constitutes 40-60% of the total protein concentration (Anderson and Anderson, 1997).

Fluid accumulations in body cavities and tissue usually result when albumin levels drop below 10 gm/L. However, fluid may accumulate with higher albumin concentrations if hypertension and loss of vessel integrity are

present. Plasma and serum proteins, act as anions in acid-base balance, take part in coagulation reactions, and serve as carriers for many compounds. In addition to albumin, plasma contains globulins, fibrinogen (removed from serum by the clotting process), glycoprotein, lipoproteins, acute phase proteins and transport proteins. The total protein value for Jersey cows was less than the lower limit of the normal physiological range (6.2-8.2 g/dL) reported by Mitruka and Rawnsley (1977). This could be attributed to depressed protein utilization or synthesis in the animal probably due to acclimatization since the breed is not native to humid tropical environment compared to other indigenous breeds. Besides, increased protein breakdown due to gluconeogenesis is another possible cause (Lone et al., 2003). Urea nitrogen for Jersey, N'Dama and Sokoto Gudali cows respectively were within the normal range (7.8-25.0 mg/dL) as reported by Mitruka and Rawnsley (1977).

Table 2
Serum biochemical variables of different breeds of dry cows before gestation.

Parameters	Jersey	N'Dama	White Fulani	Sokoto Gudali
Glucose (mg/dL)	45.40±5.27^{b}	41.55 ±1.89^{b}	57.60 ±1.43^{a}	59.40±1.28^{a}
Albumin (g/dL)	3.50±0.15	3.23±0.13	3.53±0.15	3.22±0.20
Creatinine (mg/dL)	1.04±0.86	1.23±0.04	1.20±0.10	1.26±0.10
AST (I.U/L)	35.34±9.85	29.80±3.49	31.70±4.71	58.91±15.64
ALT (I.U/L)	8.72±1.31	10.04±0.61	7.78±0.46	10.00±0.66
Total Protein (g/dL)	5.23±0.52^{b}	7.21±0.24^{a}	6.41±0.05^{a}	6.81±0.09^{a}
Globulin (g/dL)	1.73±0.37^{b}	3.98±0.11^{a}	2.87±0.01^{b}	3.58±0.11^{a}
Urea (mg/dL)	11.88±3.70	20.22±2.55	31.01±0.59	14.63±5.98
Cholesterol (g/dL)	93.45±12.34	79.84±7.58	93.22±1.92	103.91±3.00

ab : Means on same row with different superscripts are significantly different (P<0.05).
AST- Aspartate amino transferase; ALT- Alanine amino transferase.

Table 3
Haematological parameters of different breeds of cow during gestation.

Parameters	Jersey	N'Dama	White Fulani	Sokoto Gudali
Packed cell volume (%)	27.75±1.7^{b}	40.75±2.72^{a}	29.25±1.11^{b}	33.25±1.11^{b}
Haemoglobin (g/dL)	9.95±0.64^{ab}	10.30±1.08^{ab}	8.40±0.78^{b}	11.15±0.49^{a}
Erythrocytes (x10^{6}/µL)	6.10±0.20^{a}	6.62±0.13^{a}	6.36±0.15^{a}	5.18±0.21^{b}
MCV (fL)	45.49±2.65^{b}	61.55±1.76^{a}	45.99±1.54^{b}	64.19±2.34^{a}
MCH (pg)	16.31±0.25	15.56±1.21	13.21±0.46	21.53±1.89
MCHC (g/dL)	35.85±1.67	25.28±0.68	28.72±0.56	33.53±0.92
Platelets (x10^{3}/µL)	86.75±1.25^{ab}	78.25±1.38^{bc}	111.50±7.41^{a}	100.50±1.90^{ab}
Leukocytes (x10^{3}/µL)	5.99±0.15^{a}	4.87±0.10^{b}	4.68±0.25^{b}	6.69±0.49^{a}
Lymphocytes (%)	71.50±1.32^{b}	70.00±1.47^{bc}	77.50±2.33^{a}	65.50±1.94^{c}
Neutrophils (%)	23.75±1.31	23.00±0.91	26.75±2.39	28.50±2.10
Monocytes (%)	2.25±0.25	3.25±0.25	3.00±0.41	2.50±0.50
Eosinophils (%)	2.75±0.75	4.00±0.41	2.50±1.04	3.50±0.29

abc : Means on same row with different superscripts are significantly different (P<0.05).
SEM- Standard Error of means; fl- Femtolitre; pg- Picogram; MCV-Mean Corpuscular Volume; MCH-Mean Corpuscular Haemoglobin; MCHC-Mean Corpuscular Haemoglobin Concentration.

The haematological and serum biochemical response of Jersey and some indigenous cow breeds at the gestating phase are shown in Tables 3 and 4 respectively. Packed cell volume (PCV) among the cow breeds was within the normal physiological range (24-46%) for cows as reported by Mitruka and Rawnsley (1977); there was a reduction in the value at the gravid phase for Jersey cows. However, N'dama, White Fulani and Sokoto Gudali cows were observed to have increases in PCV. The inconsistency in decrease/increase across the breeds was a trend observed in haemoglobin concentration and red blood cells volume as well. Though values for both parameters in all the breeds were found to be within the normal range, no uniform reduction in the value of these parameters at the gravid phase was noticed as observed by Neelu et al. (1996) and Sattar and Mirzar, (2009). Platelet counts in

Jersey and N'Dama cows were less than the lower limit of the normal physiological range in cows, a trend which was observed in Jersey, White Fulani and Sokoto Gudali cows respectively before gestation. The low values could be due to premature destruction states such as thrombocytopenia, acute blood loss, drug effects (such as heparin), infections with sepsis, and entrapment of platelets in an enlarged spleen, or bone marrow failure from diseases such as myelofibrosis or leukemia (Cole, 1986). Leukocytes and its differentials among the breeds were within the normal range as observed by Mitruka and Rawnsley (1977), though there was significant (P<0.05) difference in lymphocyte count. It is thought to be due to breed difference. This observation suggests that no serious debilitating condition arose which posed grave danger to their health at the gravid phase.

Table 4
Serum biochemical variables of different breeds of cow during gestation.

Parameters	Jersey	N'Dama	White Fulani	Sokoto Gudali
Glucose (mg/dl)	60.95±0.83^{a}	44.88±0.32^{c}	53.39±1.25^{b}	60.81±0.56^{a}
Albumin (g/dl)	2.02±0.14^{c}	2.69±0.05^{ab}	2.57±0.12^{b}	3.00±0.03^{a}
Creatinine (mg/dl)	1.29±0.11	1.47±0.14	1.58±0.11	1.52±0.65
AST (I.U/L)	71.62±2.60^{b}	104.28±11.86^{a}	47.56±5.43^{c}	60.50±6.70^{bc}
ALT (I.U/L)	4.17±1.16^{b}	9.22±1.74^{a}	6.95±0.30^{ab}	11.02±1.44^{a}
Total Protein (g/dL)	6.38±0.79^{b}	7.68±0.19^{ab}	8.92±0.16^{a}	6.87±0.47^{b}
Globulin (g/dL)	4.36±0.65^{b}	4.99±0.14^{b}	6.35±0.04^{a}	3.87±0.44^{b}
Urea (mg/dL)	16.75±0.68^{b}	23.92±0.65^{ab}	28.24±1.41^{a}	22.06±0.64^{ab}
Cholesterol (g/dL)	47.74±1.73^{c}	97.22±3.96^{a}	63.27±1.18^{bc}	87.24±1.52^{ab}

abc: Means on same row with different superscripts are significantly different (P<0.05).
AST- Aspartate amino transferase; ALT- Alanine amino transferase.

4. Conclusion

Findings from this study revealed that despite the mild variations in values of blood parameters evaluated which were breed based, no debilitating condition was suffered nor was organ impairment recorded. It thus suggests that all four cow breeds can be successfully reared in the tropics including Jersey without adverse effect on their blood profile.

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