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World J Life Sci. and Medical Research 2011;1(3):48

ISSN 2249-0574

Adedeji et al., 2011. Coat Pigmentation and Wattle Genes' Effect on Goat

Original Article

Life Science

Coat pigmentation and Wattle Genes' Effect on some Haematological Characteristics of Heat Stressed and Extensively Reared West African Dwarf Goats

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ABSTRACT [ENGLISH/ANGLAIS]

This study is focused on the effect of coat pigmentation and wattle genes on the adaptation performance of West African Dwarf (WAD) goats in the sub-humid zone of Nigeria using purposive sampling method on-farm. Data on white blood cell, red blood cell, haemoglobin, packed cell volume; sodium and potassium were obtained from five hundred and twenty (520) goats. Data were corrected for age effect and for the fixed effect of coat pigmentation and wattle genes using General Linear Model procedure of SAS. White blood cell (WBC), red blood cell (RBC), haemoglobin (Hb), packed cell volume (PCV), serum sodium (Na^+) and potassium (K^+) were significantly (p < 0.05) influenced by coat pigmentation genes. Brown goats with white markings (aabbss) had the highest WBC (13.01±0.19x10³/μl), Na^+ (138.22±0.74 mmol/litre) and K^+ (3.80±0.06 mmol/litre) while Bezoar (A^{bz}) goats had the highest RBC (13.12±0.10 x10⁶/μl). All blood parameters were influenced (p < 0.05) by wattle genes except PCV and Na^+. Bilateral wattled (WW) goats had the highest RBC (12.66±0.05 x10⁶/μl), WBC (11.69±0.04 x10³/μl) and Hb (9.08±0.06g/dl). The interaction of Coat pigmentation x wattle gene significantly influenced (p < 0.01) all blood parameters under study except PCV and Na^+. The highest RBC and lowest K^+ were observed in non-wattled black goats while bilateral wattled black goats with white markings (aaBbss) had the highest Hb. The results established the effect of coat pigmentation and wattle genes on the haematological characteristics of heat stressed WAD goats implying that genetic improvement of adaptation of this breed can be achieved using qualitative traits as criteria for selection.

Keywords: Coat pigmentation, wattle, genes, haematological, heat tolerance, WAD goats

RÉSUMÉ [FRANÇAIS/FRENCH]

Cette étude se concentre sur l'effet de la pigmentation de la robe et des gènes d'acacia sur la performance d'adaptation des nains ouest-africains (WAD) des chèvres dans la zone sub-humide du Nigeria en utilisant la méthode d'échantillonnage raisonné sur la ferme. Les données sur les globules blancs, globules rouges, hémoglobine, hématocrite; de sodium et de potassium ont été obtenus à partir de 520 (520) chèvres. Les données ont été corrigées pour l'effet d'âge et pour l'effet fixe de la pigmentation de manteau et les gènes à l'aide d'acacia général la procédure du modèle linéaire de la SAS. Globules blancs (WBC), de globules rouges (GR), de l'hémoglobine (Hb), l'hématocrite (PCV), le sodium sérique (Na^+) et potassium (K^+) ont été significativement (p < 0,05) influencée par les gènes de pigmentation manteau. Des chèvres Brown avec des marques blanches (aabbss) avait plus la WBC (13,01 ± 0.19x10³/μl), Na + (138,22 ± 0,74 mmol / litre) et K^+ (3,80 ± 0,06 mmol / litre) alors Bezoar (ABZ) chèvres avaient le plus élevé RBC (13,12 ± 0,10 x10⁶/μl). Tous les paramètres sanguins ont été influencés (p < 0,05) par les gènes d'acacia, sauf PCV et Na +. Bilatérales wattled (WW) chèvres avaient le plus élevé RBC (12,66 ± 0,05 x10⁶/μl), WBC (11,69 ± 0,04 x10³/μl) et Hb (9,08 ± 0.06g/dl). L'interaction de la pigmentation de Coat gène X acacia significativement influencé (p < 0,01) tous les paramètres sanguins étudiés, sauf PCV et Na^+. Le plus haut RBC et le plus bas K + ont été observées chez les non-wattled chèvres noires tandis bilatéraux wattled chèvres noires avec des taches blanches (aaBbss) avaient le plus élevé d'Hb. Les résultats établis l'effet de la pigmentation de la robe et d'acacia gènes sur les caractéristiques hématologiques de chaleur souligné chèvres WAD ce qui implique que l'amélioration génétique de l'adaptation de cette race peut être réalisé en utilisant des caractères qualitatifs comme critères de sélection.

Mots-clés: Manteau de pigmentation, l'acacia, les gènes, hématologiques, tolérance à la chaleur, des chèvres WAD

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Accepted/Accepté: June, 2011

Full Citation: Adedeji1 TA, Ozoje MO, Peters SO, Sanusi OA, Ojedapo1 LO, Ige AO. Coat pigmentation and Wattle Genes' effect on some Haematological Characteristics of Heat Stressed and Extensively Reared West African Dwarf Goats. World J Life Sci. and Medical Research 2011;1(3):48-55.

INTRODUCTION

Haematological values are of importance in diagnosing many haemoparasitic infections in food animals [1, 2] and assessing the health status of ruminants [3]. The determination of haematological and biochemical indices of domestic animals is of great importance and has been well documented in literatures [4, 5]. The changes that occurred in these blood parameters have been studied in cattle [6], sheep [7], Red Sokoto goat [8] and West African Dwarf (WAD) goats [2]. Quantitative and morphological changes in blood cells are associated with heat stress and translated by variations in haematocrit value, number of circulating leukocytes, erythrocyte content and haemoglobin content. There is an increase in haematocrit counts with heat stress, which can be explained by an increase in the number of red blood cells. The heterophil/lymphocyte ratio is altered as a result of the increase in glucose concentration as a direct response to greater adrenaline and glucorticoids secretion [9]. Electrolytes can be defined as chemical that breakdown into their ionic constituents, having as their main physiological function, the maintenance of the body acid-base balance. Sodium, potassium and chloride are the essential ions for the maintenance of osmotic pressure and acid-base balance of the body fluids. Potassium is involved in antagonism, nervous conduction, excitement, muscle contraction, synthesis of tissue proteins, and maintenance of intracellular homeostasis, enzymatic reactions, osmotic and acid-base balance. Serum sodium, potassium and chloride levels are affected by heat stress. Potassium and sodium concentration decreases as temperature rises, while chloride increases with heat stress [9].

WAD goats are one of the indigenous breed of goats that are found predominantly in the humid and sub humid zones of Nigeria. They weighed 25 kg on the average at adult, measures 50 cm in height and the coat colour varies from white, brown, black and various combinations of these colours. They may or may not have wattle and if present it could be unilateral or bilateral. They are majorly reared extensively. They have the widest margin of adaptation to the environment when compare with other breeds of goats. This breed of goat has been variously characterized for physiological and blood characteristics, however, little information is available on its blood constituents in relation to the environmental temperature and qualitative traits. Therefore, this research seeks to study the response of heat stressed WAD goats in terms of its blood constituents based on coat pigmentation and wattle genes. The results of this study will serves as baseline information which could be helpful in rearing, management, health status and genetic adaptation of this breed of goat.

MATERIALS AND METHODS

Study area

The study was carried out in Ogbomoso agro-ecological zone of Oyo State, Nigeria. The zone covers a total land mass of 14.82 square kilometers. It is located approximately at the intersection of latitude 80151 North of the Equator and longitude 40 151 East of the Greenwich Meridian. It lies between 300 and 600 meters above the sea level. The annual temperature ranges between 25.50C to 40.00C and while the mean annual rainfall is 1247 mm [10]. The relative humidity is high in the early mornings (89%) with marked decrease in the afternoons (62%) throughout the year.

Animals and their management

This research was focused on apparently healthy West African dwarf goats. West African Dwarf goats in the agro-ecological zone are usually reared under the extensive system where the animal are occasionally fed with cassava peels, corn shaff, kitchen waste, crop residues and most often on rubbish heaps. This system of rearing is adopted by the people in this community so as to reduce the competition between humans and goats for food. The animals were not provided with shelter rather they sleep outside the owner's compound at night. There was no known common browse plant in the study area nor deliberate veterinary or ethno-veterinary practiced.

Data collection

Data on blood parameters were collected on five hundred and twenty apparently healthy West African Dwarf goats across Ogbomoso zone using purposive sampling technique for 12 months and categorized into four seasons. The season includes, Late dry (Jan. – March), early rain (April – June), late rain (July – Aug.) and early dry (Sept. - Dec.). Blood from each goat was collected between 1300 – 1500 hrs under the intense sun. Each goat was adequately calmed before blood collection was done. Necessary precaution was taken so as not to puncture the lung tube with the needle. After locating the jugular vein, a thumb was used to press the lower part of the vein to stop blood from circulating. Afterwards, 5 ml of blood was taken by jugular venipuncture. Out of the 5 ml of blood collected, 2.5 ml was dispensed into ethylene diamine tetra acetic acid (EDTA) bottle and labeled, while the remaining 2.5 ml was dispensed into plain (anticoagulant free) bottles and also labeled accordingly. These were done for each of of the goats included in the study. The blood with anticoagulants was used to analysed for the packed cell volume (PCV), red blood cell (RBC), white blood cell (WBC) and haemoglobin (HB). The clotted blood was used to determine the serum sodium and potassium. Determinations of PCV, RBC, WBC and HB values were obtained through the methods described by Edington and Gilles [11] while serum sodium and potassium were determined through flame photometry methods. Blood collection was done twice in each animal and in each season.

The definition and analysis of coat pigmentation genes were made in line with the reports of Adalsteinssson [12] and Ozoje [13] while the definition of wattle genes were made in line with the findings of Odubote [14].

Data Analysis

Preliminary analyses of the data obtained revealed that blood parameters were significantly ($p < 0.05$) affected by age of the animals (through dentition), sex and season, therefore, the data was subsequently adjusted. The adjusted data was analysed for the fixed effect of coat pigmentation gene, wattle gene and its interaction using the General Linear Model (GLM) procedure of SAS [15]. The significant means were separated with the use of Duncan Multiple Range Test procedure of the same statistical package. The linear model is as shown below:

Model

Y_{ijkl}	=	$\mu + A_i + B_j + (AB)_{ij} + e_{ijkl}$
Y_{ijkl}	=	the parameter of interest
μ	=	the overall mean for the parameter of interest
A_i	=	fixed effect of the i^{th} coat pigmentation gene (i = 1 to 10)
B_j	=	fixed effect of the j^{th} wattle gene (j = 1,2,3)
$(AB)_{ij}$	=	interaction effect of the i^{th} coat pigmentation gene and j^{th} wattle gene
e_{ijkl}	=	random error associated with each record

RESULTS

Tables 1 and 2 showed the analysis of variance and least square means respectively of coat colour and wattle genes on packed cell volume (PCV%), red blood cell counts (RBC x10^6/μl), white blood cell counts (WBC x10^3/μl), haemoglobin (Hb g/dl), serum sodium (mmol/L) and potassium (mmol/L) concentrations. There was a high significant ($p < 0.01$) effect of coat pigmentation genes on red blood cell counts (RBC), white blood cell counts (WBC) and haemoglobin values (Hb), serum sodium (Na^+) and potassium (K^+) concentrations. The least square means revealed that red blood cell counts ranged from 11.20±0.22 to 13.12±0.10 x10^6/μl. The black goats (aaB-S-) had the highest red blood cell count while bezoar (A^{bz}) and badgerface (A^b) goats had the lowest values which were not significantly ($p > 0.05$) different. The highest mean value of white blood cell counts was obtained in brown goats with white marking (aabbss) (13.01±0.19 x10^3/μl) while the black (aaB-S-) goats had the lowest value (11.20±0.08 x10^6/μl). Significant differences ($p < 0.05$) in the haemoglobin concentration regarding coat pigmentation genes revealed that black goats with white marking (aaBBss) had the highest value (9.60±0.12g/dl) while the lowest values were obtained in the white (A^{wh}), badgerface (A^b) and grey (A^g) goats. The mean serum sodium ranged from 137.15±0.52 to 138.25±0.94 mmol/litre. Badgerface goats (A^b) had the highest value of serum sodium concentration but not significantly ($p >$ 0.05) different from the values obtained for brown goats with white marking (aabbss) while the lowest value was obtained in the black (aaB-s-) goats. The mean value of serum potassium concentration ranged from 3.62±0.05 to 3.80±0.06 mmol/litre with brown goats with white makings (aabbss) recording the highest value while black (aaB-S-) goats had the lowest K^+.

There was a high significant effect ($p < 0.01$) of wattle genes on RBC, WBC, Hb and serum potassium. Bilateral wattled goats (WW) had the highest red blood cell counts (12.66±0.05x10^6/μl), haemoglobin (9.08±0.06g/dl) and white blood cell counts (11.69 ± 0.04 x10^3/μl) while the lowest RBC was obtained in goats with unilateral wattle (Ww). However, the lowest mean values of WBC and Hb were obtained in goats with no wattle (ww). Wattle gene significantly ($p < 0.05$) influenced serum potassium concentration with values ranging from 3.55±0.03 to 3.71±0.10 mmol/litre with the highest value observed in goats with no wattle (ww) and the lowest in the bilateral wattled (WW) goats.

The interaction effect of coat pigmentation and wattle genes was significant on RBC ($p < 0.05$), WBC ($p < 0.01$), Hb ($p < 0.05$) and potassium concentration ($p < 0.01$) with black (aaBBSS or aaBbSs) bilateral wattled (WW) goats obtaining the highest red blood cell counts and the lowest potassium concentration. However, bilateral wattled (WW) brown goats with white markings (aabbss) and bilateral wattled (WW) black goats with white markings (aaBBss) had the highest values of white blood cell and haemoglobin concentration respectively (Table 3).

TABLE 1

Table 1 shows summarized results from analysis of variance of coat pigmentation and wattle genes on the blood characteristics of heat stressed and extensively reared West African Dwarf goats

Source of variation	df	PCV %	RBC x10^6 (μl)	WBC x10^3 (μl)	Hb (g/dl)	Na^+ (mmol/L)	K^+ (mmol/L)
Coat colour gene	09	22.585	26.499**	27.582**	23.59**	200.251**	1.007**
Wattle gene	2	6.614	15.941**	14.808**	28.323**	8.900	8.247*
Coat colour gene* wattle gene	15	17.961	17.234*	18.388**	17.369*	338.633	1.318**

*RBC- Red blood cell, WBC- White blood cell, PCV- Packed cell volume, Hb- Haemoglobin, Na^+= sodium, K^+ = potassium, df : Degree of freedom, * - Significant ($p < 0.05$), ** - Highly significant ($p < 0.01$)*

TABLE 2

Table 2 shows least square means of blood parameters of heat stressed West African Dwarf goats as influenced by coat pigmentation and wattle genes in Ogbomoso

Variable	Obs	PCV %	RBC x10^6 (μl)	WBC x10^3 (μl)	Hb (g/dl)	Na^+ (mmol/L)	K^+ (mmol/L)
Overall	2597	30.02 ± 0.04	12.15 ± 0.05	11.86 ± 0.04	8.07 ± 0.05	137.59 ± 0.18	3.72 ± 0.03
Coat colour gene:							
Black(aaB-S-)	611	30.04 ± 0.88	13.12 ± 0.10^{a}	11.20 ± 0.08^{g}	9.30 ± 0.11^{bc}	137.15 ± 0.31^{e}	3.62 ± 0.03^{e}
White (A^{wh})	256	30.03 ± 0.13	11.56 ± 0.17^{e}	12.00 ± 0.12^{d}	8.70 ± 0.18^{ef}	137.60 ± 0.55^{bc}	3.70 ± 0.05^{bc}
Brown(aabbS-)	171	30.01 ± 0.13	12.10 ± 0.22^{d}	12.05 ± 0.12^{d}	9.50 ± 0.24^{ab}	137.67 ± 0.60^{b}	3.68 ± 0.07^{d}
Bagerface (A^{b})	84	29.90 ± 0.22	11.20 ± 0.22^{g}	12.50 ± 0.25^{c}	8.70 ± 0.22^{ef}	138.25 ± 0.94^{a}	3.75 ± 0.08^{ab}
Benzoar (A^{bz})	130	30.01 ± 0.12	11.45 ± 0.19^{ef}		9.20 ± 0.20^{c}	137.40 ± 0.75^{d}	3.74 ± 0.07^{ab}
Swiss markings (A^{sm})	198	30.04 ± 0.10	12.30 ± 0.10^{c}	11.80 ± 0.13^{e}	9.10 ± 0.19^{d}	137.41 ± 0.52^{d}	3.65 ± 0.05^{de}
Mahogany (A^{mh})	435	29.95 ± 0.08	13.10 ± 0.12^{ab}	11.26 ± 0.09^{f}	8.80 ± 0.12^{e}	137.55 ± 0.54^{c}	3.70 ± 0.04^{bc}
Black with white markings (aaBBss)	401	30.01 ± 0.09	13.05 ± 0.10^{b}	12.73 ± 0.10^{b}	9.60 ± 0.12^{a}	137.57 ± 0.46^{c}	3.72 ± 0.16^{abc}
Brown with white markings (aabbss)	114	29.91 ± 0.17	11.55 ± 0.20^{e}	13.01 ± 0.19^{a}	9.20 ± 0.25^{c}	138.22 ± 0.74^{a}	3.80 ± 0.06^{a}
Grey (A^{g})	132	30.02 ± 0.14	12.05 ± 0.23^{d}	11.90 ± 0.16^{d}	8.60 ± 0.23^{g}	137.62 ± 0.82^{b}	3.69 ± 0.05^{d}
Wattle gene:							
Absent (ww)	320	30.03 ± 0.12	12.45 ± 0.12^{b}	11.46 ± 0.11^{c}	9.02 ± 0.14^{c}	137.10 ± 0.45	3.71 ± 0.04^{a}
Unilateral (Ww)	54	30.08 ± 0.23	12.50 ± 0.26^{b}	11.53 ± 0.35^{b}	9.05 ± 0.33^{b}	137.13 ± 0.87	3.67 ± 0.10^{a}
Bilateral (WW)	2223	30.07 ± 0.04	12.66 ± 0.05^{a}	11.69 ± 0.04^{a}	9.08 ± 0.06^{a}	137.05 ± 0.19	3.55 ± 0.03^{b}

^{abcdefg} means within the same variable in a column with different superscripts are significantly different ($p < 0.05$)

DISCUSSION

The observed overall means of red blood cell and haemoglobin agreed with the findings of Binta et al. [16] and Daramola et al. [2]. The significance of coat pigmentation genes on the blood parameters in the present study is in agreement with the reports of Sanusi [17] in West African dwarf sheep, and this suggests that coat pigmentation of West African dwarf goats is an important determinant of blood characteristics under high environmental temperature. The highest red blood cell counts and haemoglobin concentration obtained in the black goats could be an indication that these animals were thermally stressed because of the high heat absorbance rate of their coat pigmentation.

This is in line with the observation of Borges et al. [9] in sheep. They reported that the quantity of red blood cell counts increased with heat stress. Also, Swenson [18] noted that increased red blood cell counts and haemoglobin concentration under the sun is related to increase activity (physical and metabolic). However, the increased quantity of red blood cell counts and hemoglobin concentration during heat stress could be as a result of reduced oxygen tension leading to an increased production and release of erythropoietin, thereby stimulating erythropoiesis as a coping or adaptive mechanism to low oxygen level [19]. Thus, the highest values of red blood cell count and haemoglobin

TABLE 3

Table 3 shows Least squares means of the interaction effect of coat pigmentation and wattle genes on the blood parameters of heat stressed West African Dwarf goats in Ogbomoso

Variable	Wattle Gene	Obs	PCV %	RBC x10^6 (µl)	WBC x10^3 (µl)	Hb (g/dl)	Na^+ (mmol/L)	K^+ (mmol/L)
Black (aaB-S-)	Absent (ww)	74	30.04±0.24	11.90±0.16	11.35±0.20	9.67±0.25	136.67±0.74	3.60±0.08
	Unilateral (Ww)	15	30.01±0.41	12.64±0.05	11.42±0.61	9.02±0.41	136.58±1.85	3.54±0.17
	Bilateral (WW)	510	29.98±0.08	13.09±0.11	12.10±0.08	10.07±0.12	136.39±0.34	3.68±0.03
White (A^{wh})	Absent (ww)	12	30.00±0.76	11.25±0.60	11.18±0.43	9.10±0.60	137.75±1.03	3.43±0.16
	Unilateral (Ww)	9	30.08±0.05	11.00±0.50	11.67±0.67	9.00±0.50	138.27±1.33	3.57±0.22
	Bilateral (WW)	235	29.23±0.13	11.90±0.19	12.56±0.13	9.90±0.19	137.23±0.58	3.81±0.05
Brown (aabbS-)	Absent (ww)	25	30.02±0.34	10.26±0.34	11.81±0.13	8.95±0.34	136.88±1.44	3.56±0.02
	Unilateral (Ww)	6	30.00±3.00	11.00±3.01	12.70±2.59	10.00±3.12	138.00±2.04	3.70±3.02
	Bilateral (WW)	135	29.97±0.14	11.32±0.29	12.30±0.14	9.32±0.29	137.80±0.59	3.90±0.08
Badgerface (A^b)	Absent (ww)	6	30.02±0.18	12.30±0.31	11.50±0.67	9.00±0.45	136.89±3.35	3.65±0.07
	bilateral (WW)	78	30.03±0.24	11.28±0.23	13.02±0.25	8.97±0.23	137.12±0.84	3.58±0.08
Benzoar (A^{bz})	Absent (ww)	6	30.03±0.00	11.00±0.00	12.00±0.00	8.90±0.00	137.00±2.10.	2.90±2.11
	bilateral (WW)	136	29.90±0.12	12.77±0.20	11.70±0.20	9.77±0.21	136.91±0.78	3.87±0.07
Swiss markings	Absent (ww)	18	30.04±0.32	11.17±0.81	11.07±0.49	7.92±0.77	136.93±1.83	3.87±0.11
(A^{sm})	Unilateral (Ww)	6	30.07±0.00	11.60±0.00	12.80±0.00	10.00±0.00	136.90±0.01	3.80±0.00
	Bilateral (WW)	174	30.98±0.11	11.24±0.17	12.66±0.13	9.86±0.19	136.95±0.53	3.65±0.00
Mahogany (A^{mh})	Absent (ww)	96	30.05±0.15	12.93±0.20	12.59±0.23	10.32±0.22	137.88±0.65	3.59±0.09
	Unilateral (Ww)	15	30.01±0.11	11.93±0.90	12.26±0.29	10.10±1.02	137.60±1.45	3.86±0.20
	Bilateral (WW)	324	30.07±0.10	12.11±0.14	11.74±0.10	10.02±0.14	137.79±0.70	3.87±0.05
Black with white	Absent (ww)	36	30.00±0.01	13.00±0.01	11.40±0.02	9.70±0.01	137.00±0.02	3.50±0.01
markings(aaBBss)	Unilateral (Ww)	3	29.95±0.10	11.92±0.11	12.13±0.11	10.31±0.13	136.29±0.50	3.05±0.18
	Bilateral (WW)	362	30.05±0.34	12.50±0.15	11.18±0.71	10.50±1.15	137.50±2.50	3.55±0.10
Brown with	Absent (ww)	12	30.05±0.34	11.50±0.15	11.18±0.71	9.50±1.15	137.50±2.50	3.55±0.10
white markings	bilateral (WW)	102	30.03±0.18	12.53±0.21	13.05±0.19	9.80±0.24	137.06±0.77	3.73±0.06
(aabbss)								
Grey (A^g)	Absent (ww)	5	30.09±0.64	13.00±1.00	12.72±0.32	9.70±1.86	137.00±3.67	3.60±0.49
	bilateral (WW)	140	29.98±0.15	11.97±0.23	11.44±0.16	9.03±0.23	136.86±0.84	3.79±0.05

concentration obtained in black goats could be an evidence of adaptation of these animals to low atmospheric oxygen during the period of intense heat. The overall mean of white blood cell count in this study, is in line with the findings of Dalapati et al. [20] in Black Bengal and the findings of Tibbo et al. [19] on Arsi Bale, Central Highland and Long-eared Somali goats but lower than the value reported by Aba-Adulugba and Joshua [21] in West African dwarf goats of Nigeria and this showed that the animals were freed of any sub-clinical parasitic infection [3]. The significant differences in the values of white blood cell counts under the influence of coat pigmentation genes suggest the evidence of response variation in WBC to coat pigmentation. The highest value of white blood cell count in brown goats with white marking indicates that these animals possess protective system, which could provide a rapid and potent defense against any infectious agent. This defensive mechanism is indeed important in the tropics because of high prevalence rate of diseases militating against survival and growth of livestock species. However, Fesus et al. [22] did not observe any significant effect of coat colour genotypes on white blood cell counts of crossbred pigs. The overall mean of serum sodium and potassium concentrations in the present study falls within the values previously reported [8, 2]. The significant differences in serum sodium and potassium concentrations are also in agreement with the findings of Sanusi [17]. The highest values of serum sodium and potassium concentrations as obtained in the badgerface and brown goats with white marking respectively reflects the superiority of these animals to withstand the rigors of climatic stress under warm conditions. However, high level of serum potassium concentration has been attributed to excessive tissue protein catabolism associated with protein deficiency [23]. Lowered levels of serum and potassium concentrations during the hot weather might be due to loss of sodium ions in urine under tropical environmental condition [24]. Borges et al. [9] reported a decreased plasma electrolyte especially the cations with increased body temperature. However, Srikandakumar and Johnson [25] also reported similar findings in the Australian milking zebu but found increased concentration of plasma potassium in Holstein and Jersey cows due to heat stress.

The significant effect of wattle genes on white blood cell, red blood cell, haemoglobin and serum potassium in favour of the bilateral wattled West African dwarf goats, could be an indication to adaptation and extensive distribution of these animals in a thermally stressful environment of the sub-humid zone. As observed, the bilateral wattled goats had increased red blood cell which is expected in a thermally stressful situation. However, possession of wattle which is a heat regulator [14] mechanism in WAD goats might have ameliorated the effect of the heat burden which could be through increased haemoglobin, serum and potassium concentrations to combat reduced oxygen tension experienced during intense heat period. The lowered level of serum potassium concentration observed in goats with no wattle could be attributed to an increase excretion of this ion during heat stress and an increase in intracellular potassium ions [26, 27]. This could be an adaptive feature of goats with no wattle to cope with high heat load in a thermally stressful environment.

Increased red blood cell and decreased serum potassium concentration in the black bilateral wattled goats indicate that these animals were thermally stressed. Borges [26] reported decreased serum sodium and potassium concentrations as temperature rises. However, other animals were able to maintain their acid-base ratio under the same condition and this could not be far from the reflective nature of their pigmentation which provided adequate comfort.

CONCLUSION

The results established the significance of coat pigmentation and wattle genes on the haematological parameters of heat stressed WAD goats in Ogbomoso implying that genetic improvement and adaptation of this breed can be achieved using qualitative traits as criteria for selection.

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ACKNOWLEDGEMENT / SOURCE(S) OF SUPPORT

Nil

CONFLICT OF INTEREST

No conflict of interest was declared by authors.