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ARTICLE

Effect of Metabolic Excesses from Dietary Proteins on Blood Profile of Heat-stressed Broilers

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ABSTRACT

Although, dietary proteins play a crucial role in poultry profit maximization, through the sustenance of birds` welfare, growth and development, yet metabolic excesses from crude protein (CP) degradation is detrimental to broiler chickens (BC) affected by heat stress. This study evaluated the effect of dietary protein levels on blood profile of heat-stressed BC at starter phase (SP) and finisher phase (FP). Arbor Acre BC (n=288) were randomly allotted to four dietary treatments (T1- 23% CP; T2- 21% CP; T3- 19% CP; and T4- 17% CP) with six replicate groups in a completely randomized design. Data were subjected to descriptive analysis, analysis of variance (p=0.05) and correlation statistics. Protein intake (PI) was not significantly affected by varying CP in diets at SP, but not at FP, where PI significantly increased with increasing dietary CP. PER had a negative correlation with PCV (r= -0.89, p<0.01), Hb (r= -0.88, p<0.01), RBC (r= -0.93, p<0.01) and PI (r= -0.78, p<0.01). Metabolic excesses including heat dissipation from dietary proteins influenced PCV, Hb, platelets and glucose of heat-stressed broilers.

1. Introduction

As an established scientific fact, blood parameters showcase the health status of animals, and they are crucial in the evaluation of the physiology of farm animals. Dietary proteins are important, as they play crucial roles in coordinated feed intake, regulation of homeostasis and metabolism of nutrients, among others. When ingested, proteins undergo hydrolysis in the gastro intestinal tract (GIT) and release smaller units known as amino acids (AA) that functions in structural development, blood components, and hormonal activities in the body [1]. According to Beski *et al.* [2], proteins are vital in livestock feeds and they sustain life alongside other nutrients such as carbo-

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hydrates, fats, crude fibre, water, vitamins and minerals. These proteins are structural polymers, consisting of linkages of AA to form compounds possessing carbon structure, amino and carboxyl groups [3].

Dietary proteins from plant based products are complex and differ as some are heterogeneous and include those obtained from cereals and may exhibit cytoplasmic and storage functions. Storage proteins are rich in large volume of amino acids, while cytoplasmic proteins contain less of some amino acids, but more of arginine and lysine, and are therefore considered more nutritionally advantageous than storage proteins [4]. The metabolic fate of ingested dietary proteins involves proteinase action of degradation into a pool of biologically active peptides that are further hydrolyzed by peptidases into small-sized peptides that are either absorbed or form free amino acids. However, these sets of degraded proteins exhibit a variety of functions in the gastrointestinal tract [5]. Yvon *et al.* [6] noted that various degraded protein segments function in the GIT to modulate nutrient absorption, digestive enzymes and metabolism.

Pulses contain considerable amounts of proteins, although unprocessed pulse seeds contain anti-nutritional factors that decrease protein digestibility if not properly processed [7]. Soy proteins from soyabeans contain high protein content of 35 to 40% on dry weight [8]. According to [5], about 90% of these soya proteins exist as storage proteins, and are primarily glycoprotein composed of both acidic and basic polypeptides. Biolo *et al.* [9] noted that the splanchnic tissues retain 20 to 50% of essential AA from ingestion of foods by humans. However, branched chain AA are exceptions, with approximately 80% of dietary proteins being found in blood circulation [10], and may influence physiological functions. Popoola *et al.* [11] opined that poultry meat quality reduction and loss of customers` preference to meat of chickens under heat stress may persist in the 21st century poultry farming systems and necessitates prompt solutions [12]. Therefore, this study was implemented to establish the effect of metabolic excesses from dietary proteins on blood profile of heat-stressed BC.

2. Materials and Methods

This study began shortly after the decision of the Institution`s Animal Care and Use Committee was relayed through the Department of Animal Science. The experimental location was the Poultry Unit of the Teaching and Research Farm, University of Ibadan, Nigeria. A day-old Arbor Acre BC (n=288) with initial body weight of 41±3g were randomly allotted to four dietary treatments (CP, %: 23, 21, 19, 17) at pre-starter phase and 21, 19, 17 and 15% CP at finisher phase with six replicate groups, in a completely randomized design in an attempt to establish the influence of metabolic excesses from dietary proteins on blood profile of BC at starter and finisher phases. Aggregate DEB were computed as defined by Popoola and Iyayi [13], and the assumptions that guarded the derived equations were put forward by Popoola *et al.* [11] in a concept for an ideal DEB.

Feed intake (FI, g/bird) was calculated by subtracting the amount of feed left over in a specific time from the amount of feed initially supplied. This difference was thereafter divided by the number of birds in each replicated group to obtain estimated mean feed intake values per bird. Body weight gain was calculated by subtracting the initial weight from the final weights on a weekly basis. Birds were served drinkable water as described by Popoola *et al.* [14]. Mean environmental temperature and relative humidity were recorded daily. At the end of each phase, venous blood samples (5 mL) were collected using sterilized needles to puncture the brachial vein in two birds per replicate pen whose weights were closest to the mean class weight. Samples were fractionated, with a portion (2 mL) put into anticoagulant (EDTA) bottles for determination of haematology and others (3 mL) saved for blood glucose determination. Parameters measured for haematology includes the volume of packed cells (PCV), count of white blood cells (WBC) and differentials [15],[16], haemoglobin (Hb) (determined by Sahli's haemoglobinometer), and Red blood cells (RBC). The differential leukocyte counts were made on monolayer blood films and fixed in absolute methanol for five minutes and were subsequently stained and examined under a light microscope as described by Dacie and Lewis [17]. Blood glucose (GLU) was also assessed. Proximate analysis of the feeds was determined according to AOAC [18] procedure. Sodium and potassium concentrations in feeds were determined using Flame spectrophotometer; and chloride using titration [19]. Data obtained were descriptively analyzed, and through the analysis of variance statistics, differences among treatment means were determined using SAS package [20] and means were compared using Duncan Multiple Range Test at a 95% level of probability. Also, correlation statistics were done to evaluate the relationship between different dependent variables.

3. Results

3.1 Chemical Composition of Dietary Treatments

Table 1 shows the chemical composition of dietary treatments offered to heat-stressed broiler chickens at both starter and finisher phases. It was observed that dietary

crude protein levels were the only differentiating factor contributing to variations among raised broiler chickens, with a 2% sequential reduction from the standard CP levels at SP and FP.

3.2 Performance of Heat-stressed Broilers

Table 2 shows the performance of heat-stressed broilers on different dietary crude protein at starter and finisher phases. Feed intake (FI) was not substantially (P=0.58) affected by varying CP levels at SP, but at finisher phase. Body weight gain (BWG) of birds on T1 and T2 were similar and were higher (P=0.00) compared to T3 and T4 at finisher phase. Although, at starter phase, no vivid differences were observed in BWG values of birds on T1, T2 and T3. At starter phase, feed conversion ratio (FCR) value in T1 (1.64) was lower compared to T4 (2.03), but was similar to T2 and T3. However, at finisher phase, T2 (1.87) was lower in FCR value compared to T1 (2.11) and T4 (2.35), but was similar to T3 (1.98).

Feed efficiency (gain: feed) in T1 (0.63) was higher than T4 (0.50), but did not differ from T2 (0.55) and T3 (0.57) at starter phase. However, at finisher phase, T2 had the highest feed efficiency value. Protein intake (PI) in heat-stressed birds was not affected (P=0.58) by varying CP diets at starter phase, but not at finisher phase, where PI increased (P=0.00) with increasing dietary CP. Protein efficiency ratio (PER) was substantially affected by varying CP levels at starter and finisher phases with non-transverse effects observed with increasing levels of dietary CP. Higher CP levels in diets reduced (P=0.01) PER value at finisher phase, while at starter phase, an increase in PER was observed with increasing dietary CP.

3.3 Haematology and Blood Glucose of Heat-stressed Broilers

Table 3 shows the haematology and blood glucose of heat-stressed broiler chickens on varying dietary protein at starter phase. Haemoglobin value, RBC, lymphocytes, heterophils, monocytes, eosinophils, basophils, platelets, heterophils: lymphocytes and blood glucose values of heat-stressed birds were not affected by varying dietary CP and values ranged from 9.18 to 10.25g/dL, 3.16 to 3.44 (10^6/µL), 9.84 to 11.50 (10^3/µL), 5.27 to 6.20 (10^3/µL), 0.51 to 0.64 (10^3/µL), 0.59 to 0.76 (10^3/µL), 0.03 to 0.06 (10^3/µL), 15.58 to 16.98 ($x10^4$), 0.49 to 0.61, and 267.10 to 293.16mg/dL, respectively. However, PCV in T1 (31.00) and T4 (31.17) were higher compared to T3 (28.33), but did not differ from T2 (29.33). The lowest WBC value was observed in T1 (16.96), while T3 (19.07) had the highest WBC value.

Table 4 shows the haematology and blood glucose of heat-stressed broiler chickens on varying dietary protein at finisher phase. Higher value of PCV was observed in T1 (29.33) compared to other dietary treatments. However, the T2 (26.83) and T3 (27.00) had similar PCV values. The Hb value observed in T1 (9.82) was higher compared to T2 (8.98), but was similar to T3 (9.03) and T4 (9.23). Higher basophils value was observed in birds on T4 (0.12) compared to T2 (0.00), but was similar to T1 (0.06) and T3 (0.03). Platelets count in birds on T2 (27.28) was higher compared to T1 (18.67) and T4 (16.36), but was similar to T3 (23.78). Birds on T2 (284.58) had higher GLU value compared to other dietary treatments. However, the RBC, WBC, lymphocytes, heterophils, monocytes, eosinophils, and H: L values were not substantially (P=0.94) affected by varying CP and values ranged from 3.14 to3.49(10^6/µL), 17.19 to 19.22 (10^3/µL), 11.49 to 12.84 (10^3/µL), 4.27 to 5.16 (10^3/µL), 0.42 to 0.56 (10^3/µL), 0.71 to 0.86 (10^3/µL), and 0.38 to 0.43, respectively.

PCV-Packed cell volume, Hb- Haemoglobin concentration, RBC- Red blood cell, WBC- white blood cell, Lymp- Lymphocyte, Hetero-Heterophil, Mono-Monocyte, Eos- Eosinophils, Baso- Basophils, GLU- Glucose, SEM-Standard error of mean, P Value- probability, Dietary electrolyte balance: 240mEq/Kg.

3.4 Correlations between Protein Intake Efficiency and Blood Parameters of Heat-stressed Broilers

Table 5 shows the correlation between protein intake efficiency and blood parameters of heat-stressed birds at finisher phase. It was observed that the PCV was strongly and positively correlated with Hb ($r=0.92$, $p<0.01$) , RBC ($r= 0.76$, $p<0.01$), and basophil ($r= 0.48$, $p<0.01$), but had a strong and negative correlation with WBC ($r= -0.55$, $p<0.05$), lymphocytes ($r= -0.65$, $p<0.01$), eosinophils ($r= -0.34$, $p<0.01$), platelets ($r= -0.67$, $p<0.05$), GLU ($r= -0.41$, $p<0.01$) and PER ($r= -0.89$, $p<0.01$). Hb was also positively correlated with PI ($r= 0.69$, $p<0.01$), PCV ($r=0.92$, $p<0.01$), RBC ($r=0.86$, $p<0.01$), monocytes ($r= 0.69$, $p<0.01$), and basophil ($r=0.37$, $p<0.01$). Lymphocytes had a strong and positive correlation with PI ($r=0.09$, $p<0.01$) and PER ($r=0.32$, $p<0.05$). Monocytes was strongly and positively correlated with PI ($r=0.59$, $p<0.05$), but was negatively correlated with PER ($r= -0.47$, $p<0.01$). However, monocyte was also strongly correlated with other blood parameters such as PCV, Hb, RBC, lymphocytes, eosinophils, basophils and blood glucose. The PI was positively correlated with PCV ($r=0.55$, $p<0.05$), Hb ($r=0.69$, $p<0.01$), RBC ($r=0.89$, $p<0.01$), heterophils ($r= 0.58$, $p<0.05$), monocytes ($r=0.59$, $p<0.05$), and H:L ($r=0.71$, $p<0.05$), but was strongly and negatively correlated with eosinophils ($r= -0.73$, $p<0.01$), basophils ($r= -0.38$, $p<0.01$) and PER ($r= -0.78$, $p<0.01$).

Table 1. Chemical composition (g/100g) of dietary treatments fed to heat-stressed broiler chickens

	Starter phase				Finisher phase			
Nutrients (%)	**T1**	**T2**	**T3**	**T4**	**T1**	**T2**	**T3**	**T4**
Crude protein	22.87	21.10	18.80	17.20	20.89	18.83	17.20	15.33
ME, kcal/kg	3062.08	3047.30	3046.63	3081.40	3038.90	3046.63	3083.08	3087.65
Ether extract	3.88	3.83	3.80	3.82	3.84	3.80	3.81	3.78
Crude fibre	3.45	3.44	3.28	3.08	3.49	3.28	3.08	2.93
Calcium	1.00	1.03	1.00	1.04	1.03	0.99	1.02	1.02
Total phosphorus	0.80	0.74	0.70	0.69	0.74	0.69	0.67	0.65
NPP	0.43	0.43	0.42	0.41	0.43	0.42	0.41	0.40
Ca:NPP	2.33	2.39	2.38	2.54	2.39	2.36	2.49	2.55

ME- Metabolizable energy, NPP-Non-phytate phosphorus, Ca- Calcium, CP- Crude protein

Table 2. Performance of heat-stressed broilers on different dietary crude protein.

Phases	**Parameters**	**T1**	**T2**	**T3**	**T4**	**SEM**	**P Value**
	FI (g/bird)	421.50	413.33	392.50	379.67	23.34	0.58
	BWG (g/bird)	261.83^{a}	228.11^{ab}	222.44^{ab}	187.16^{b}	18.32	0.07
Starter	FCR (g/g)	1.64^{b}	1.85^{ab}	1.83^{ab}	2.03^{a}	0.12	0.21
	Gain: Feed (g/g)	0.63^{a}	0.55^{ab}	0.57^{ab}	0.50^{b}	0.04	0.17
	PI (g/bird)	96.95	95.07	90.28	87.32	5.37	0.58
	PER (g/g)	2.73^{a}	2.39^{ab}	2.47^{ab}	2.17^{b}	0.17	0.17
	FI (g/bird)	1777.33^{a}	1617.83^{b}	1485.58^{c}	1462.08^{c}	24.63	0.00
	BWG (g/bird)	866.08^{a}	869.08^{a}	757.50^{b}	623.08^{c}	40.57	0.00
Finisher	FCR (g/g)	2.11^{b}	1.87^{c}	1.98^{bc}	2.35^{a}	0.10	0.02
	Gain : Feed (g/g)	0.49^{b}	0.54^{a}	0.51^{ab}	0.43^{c}	0.02	0.02
	PI (g/bird)	373.24^{a}	307.39^{b}	252.55^{c}	219.31^{d}	4.25	0.00
	PER (g/g)	2.32^{b}	2.83^{a}	2.99^{a}	2.85^{a}	0.12	0.01

^{abcd} Means along a column with different superscripts differed significantly ($P<0.05$) using DMRT. Starter treatments (T1-23% CP; T2-21% CP; T3-19% CP; T4-17% CP), Finisher treatments (T1-21% CP; T2-19% CP; T3-17% CP; T4-15% CP), FI- Feed intake, BWG-Body weight gain, FCR-Feed conversion ratio, PI-Protein intake, PER-Protein efficiency ratio.

Table 3. Haematology and blood glucose of heat-stressed broiler chickens on varying dietary protein at starter phase

Crude protein (%)	PCV (%)	Hb (g/dL)	RBC (106/µL)	WBC (103/µL)	Lymp (103/µL)	Hetero (103/µL)	Mono (103/µL)	Eos (103/µL)	Baso (103/µL)	Platelets (x 104)	GLU (mg/dL)	Hetero: Lymp
T1 (23%)	31.00[a]	10.00	3.44	16.96[b]	9.84	5.99	0.51	0.59	0.06	16.49	267.10	0.61
T2 (21%)	29.33[ab]	9.53	3.24	17.55[ab]	10.91	5.27	0.64	0.67	0.06	15.58	282.91	0.51
T3 (19%)	28.33[b]	9.18	3.31	19.07[a]	11.50	6.20	0.57	0.76	0.03	16.98	293.16	0.54
T4 (17%)	31.17[a]	10.25	3.16	17.97[ab]	11.32	5.42	0.59	0.59	0.03	15.86	271.37	0.49
SEM	1.29	0.45	0.22	1.00	1.80	0.57	0.21	0.32	0.02	1.84	19.96	0.07
P Value	0.37	0.36	0.82	0.52	0.64	0.56	0.81	0.93	0.86	0.95	0.79	0.69

PCV-Packed cell volume, Hb- Haemoglobin concentration, RBC- Red blood cell, WBC- white blood cell, Lymp- Lymphocyte, Hetero-Heterophil, Mono-Monocyte, Eos- Eosinophils, Baso- Basophils, GLU- Glucose, SEM- Standard error of mean, P Value-probability, Dietary electrolyte balance: 270mEq/Kg.

Table 4. Haematology and blood glucose of heat-stressed broiler chickens on varying dietary protein at finisher phase

Crude protein (%)	PCV (%)	Hb (g/dL)	RBC (106/µL)	WBC (103/µL)	Lymp (103/µL)	Hetero (103/µL)	Mono (103/µL)	Eos (103/µL)	Baso (103/µL)	Platelets (x 104)	GLU (mg/dL)	Hetero:Lymp
T1 (21%)	29.33[a]	9.82[a]	3.49	17.63	11.49	4.82	0.56	0.71	0.06[ab]	18.67[b]	230.70[b]	0.43
T2 (19%)	26.83[b]	8.98[b]	3.29	19.22	12.84	5.16	0.42	0.80	0.00[b]	27.28[a]	284.58[a]	0.43
T3 (17%)	27.00[b]	9.03[ab]	3.14	17.99	11.87	4.83	0.51	0.75	0.03[ab]	23.78[ab]	225.70[b]	0.41
T4 (15%)	27.83[ab]	9.23[ab]	3.22	17.19	11.52	4.27	0.43	0.86	0.12[a]	16.36[b]	239.17[b]	0.38
SEM	1.14	0.40	0.21	1.23	1.18	0.71	0.24	0.21	0.03	2.45	15.28	0.07
P Value	0.41	0.46	0.68	0.69	0.97	0.94	0.75	0.68	0.07	0.02	0.04	0.94

[ab]Means for treatments within a column with no common superscript showed significant ($P < 0.05$) differences using DMRT.

Also, PER had a strong and negative correlation with PCV (r= -0.89, p<0.01), Hb (r= -0.88, p<0.01), RBC (r= -0.93, p<0.01), monocytes (r= -0.47, p<0.01), basophil (r= -0.18, p<0.01) and PI (r= -0.78, p<0.01) and positively correlated with eosinophils (r= 0.47, p<0.01).

4. Discussion

The extent of adaptation to heat stress conditions by poultry birds is dependent on the enhancing strategies adopted during thermal conditioning in chicks [21]. Popoola *et al.* [22] affirmed that tropical regions face more difficulty raising fast-growing chickens because birds suffer from physiological disorders that limit efficient productivity. Ideal DEB is prerequisite to blood acid-base balance and reduced incidences of hemodilution in heat-stressed broilers, and if supplied in adequate amount, there would be a substantial positive feedback [23]. Similarly, dietary proteins and their respective degraded segments (peptides and amino acids) may also affect physiological functions through the alteration of endogenous peptides stability. According to McGuinness *et al*. [24], components obtained from protein degradation in the digesta enhanced the release of cholecystokinin by inhibiting duodenal cholecystokinin-releasing factor break down. Trypsin inhibitor compounds increase cholecystokinin release and the interaction between protein-digested products and gut peptides also influence gastrointestinal tract functions and dictates the metabolic responses.

The results of current study corroborates the reports of Si *et al.* [25] who also noted reduced appetite in birds fed low-CP diets. Current findings are consistent with the reports of Yakout *et al.* [26] and Moustafa *et al*. [27] who noted improved feed conversion ratio in hens fed diets with high crude protein. Contrarily, Meluzzi *et al.* [28] and Bunchasak *et al.* [29] noted that feed intake and feed conversion ratio were not significantly affected by varying crude protein diets in laying hens at first stage of production cycle. In an attempt to optimize the use of dietary crude protein in poultry nutrition, as well as reducing the cost of feed and overall production process, indiscriminate use of dietary crude protein has resulted in diversity in choice of nutritional manipulations and detrimental outcomes. Current study affirms the reports of Zeng *et al.* [30], who opined that the role of nutritionists is to reduce the cost of feeds compounded while ensuring the efficiency of either low or high protein diets to meet amino acid standards, as proper nutrition will optimize production performance and reduce the adverse effects of the environment. Popoola *et al.* [31] noted that altered blood acid-base balance elevates body temperature and consequently reduce European production index in broilers. Therefore, avoiding excess supply of proteins and amino acids in feeds fed to broilers could help reduce nitrogen release in litters [32] and the amount of faecal nitrogen available for denitrification, while ensuring

Table 5. Correlation between protein intake efficiency and blood parameters of heat-stressed broilers at finisher phase

	PCV	Hb	RBC	WBC	Lymp	Hetero	Mono	Eos	Baso	Plat	GLU	H:L	PI	PER
PCV		0.92**	0.76**	-0.55*	-0.65**	-0.31ns	0.54ns	-0.34**	0.48**	-0.67*	-0.41**	0.22ns	0.55ns	-0.89**
Hb	0.92**		0.86**	-0.47ns	-0.61*	-0.17ns	0.69**	-0.53ns	0.37**	-0.59ns	-0.40*	0.32ns	0.69**	-0.88ns
RBC	0.76**	0.86**		-0.04ns	-0.18ns	0.20ns	0.50**	-0.55**	0.03ns	-0.24ns	0.04ns	0.44ns	0.89**	-0.93**
WBC	-0.55*	-0.47ns	-0.04		0.97**	0.90**	-0.31*	-0.03ns	-0.91ns	0.95ns	0.82**	0.51**	0.28*	0.21ns
Lymp	-0.65**	-0.61*	-0.18	0.97**		0.78**	-0.52**	0.18*	-0.81ns	0.91**	0.89ns	0.34**	0.09**	0.32*
Hetero	-0.31ns	-0.17ns	0.20	0.90**	0.78**		0.11ns	-0.43ns	-0.96ns	0.89**	0.56**	0.69ns	0.58ns	-0.02ns
Mono	0.54*	0.69**	0.50*	-0.31ns	-0.52*	0.11ns		-0.87**	-0.02*	-0.22ns	-0.66*	0.34ns	0.59*	-0.47**
Eos	-0.34ns	-0.53*	-0.55*	-0.03ns	0.18ns	-0.43ns	-0.87ns		0.35*	-0.11ns	0.37ns	-0.49ns	-0.73ns	0.47*
Baso	0.48ns	0.37ns	0.03	-0.91**	-0.81**	-0.96**	-0.02ns	0.35ns		-0.96**	-0.53**	-0.61**	-0.38ns	-0.18ns
Plat	-0.67**	-0.59*	-0.24	0.95**	0.91**	0.89**	-0.22**	-0.11*	-0.96ns		0.63**	0.47**	0.15**	0.38*
GLU	-0.41ns	-0.40ns	0.04	0.82**	0.89**	0.56*	-0.66ns	0.37ns	-0.53ns	0.63**		0.26*	0.13ns	0.08ns
H:L	0.22ns	0.32ns	0.44	0.51*	0.34ns	0.69**	0.34ns	-0.49ns	-0.61ns	0.47*	0.26ns		0.71ns	-0.43ns
PI	0.55*	0.69**	0.89**	0.28ns	0.09ns	0.58*	0.59*	-0.73**	-0.38**	0.15ns	0.13ns	0.71*		-0.78**
PER	-0.89**	-0.88**	-0.93**	0.21ns	0.32ns	-0.02ns	-0.47**	0.47**	-0.18**	0.38ns	0.08ns	-0.43ns	-0.78**	

**P<0.01; *P<0.05; ns- not significant.

broiler growth and efficient productivity [33]. The report of current study corroborates the assertions of Akhavan *et al.* [34] who reported that the interactive effect of ingested dietary proteins and glucose depends on some factors such as AA composition, digestion kinetics and AA utilization in the GIT. Krebs [35] noted that AA released from dietary proteins have direct and indirect effects on the metabolism of glucose. The direct effects are substrate-mediated, while the indirect effects are hormone-mediated. The observed differences in blood glucose levels in heat-stressed broiler chickens in present study could be well explained by Roden *et al.* [36] who noticed that an elevation of amino acids in the plasma led to an increase in the secretion and ratio of insulin and glucagon that affects hepatic glucose metabolism. Lynch *et al.* [37] noted that amino acids such as arginine and leucine are most potent in stimulating pancreatic insulin release and therefore decreasing plasma glucose concentration.

Corzo *et al.* [38] reported that minimizing excess dietary AA resulted in improved performance of broiler chickens when low crude protein diet was fed. Hindrichsen *et al*. [39] reported that altering feeding practices to achieve improved efficiency of nutrients in animals could result in significant reduction in the amounts of ammonia released during production and nitrous oxide released from animal manure during storage. Present findings agree with the observations of [40] who opined that diet is one of the factors influencing RBC and WBC in livestock. From current study, the protein intake had a strong and positive correlation with PCV, Hb, RBC, heterophils, monocytes and H: L, while PER had a strong and negative correlation with PCV, Hb, RBC, monocytes, basophil and PI. Present findings were consistent with the reports of [41] who noted that the reduction in the concentration of PCV in blood usually suggests the presence of a toxic factor, and it is worthy to note that relatively lower PCV value in heat-stressed broilers on low CP diets depicted an inefficient dietary protein utilization, owing to the strong negative correlation existing between PER and PCV and these suggest birds` physiological disposition to nutrition.

5. Conclusions

Unabsorbed amino acids reflect low dietary protein efficiency and dissociate into ions that metabolically alter blood ionic balance and physiological status of heat-stressed broiler chickens. These metabolic excesses including heat dissipation from dietary protein degradation collectively influenced PCV, Hb, platelets and blood glucose of heat-stressed broilers.

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Abbreviations

AA-Amino acids
Baso- Basophils
BC-Broiler chickens
BWG-Body weight gain
CP- Crude protein
DEB-Dietary electrolyte balance
EDTA- Ethylene diamine tetra-acetic acid
Eos- Eosinophils
FCR-Feed conversion ratio
FI- Feed intake
FP-Finisher Phase
GIT-Gastro intestinal tract
GLU- Glucose
Hb-Haemoglobin
Hetero-Heterophils,
Lymp- Lymphocyte
Mono-Monocytes
PCV-Packed cell volume,
PER-Protein efficiency ratio
PI-Protein intake
RBC- Red blood cells
SEM- Standard error of mean,
SP-Starter phase
WBC-White blood cells