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Thermoregulatory, growth and blood indices of broiler chicks fed betaine hydrochloride supplemented diets under high ambient temperature

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Abstract

The study was carried out to determine the effect of dietary inclusion of Betaine Hydrochloride on the thermoregulatory, growth, haematological and serum biochemical indices of broiler chicks under high ambient temperature because Betaine is a organic osmolyte that can protect the birds from oxidative stress. Betaine Hydrochloride was included at 0, 1.5, 3 and 4.5 g/kg feed, respectively. One hundred and eighty, one day old Hubbard broiler chicks were allotted into four treatments with three replicates each in a completely randomized design (CRD). There were no differences (p>0.05) in the rectal temperature and heart rate across the treatments. Chicks fed 1.5 and 4.5 g/kg diet Betaine Hydrochloride had better (p>0.05) feed intake, weight gain and feed conversion ratio than birds fed control and 3 g/kg diet Betaine hydrochloride. Haematological and serum biochemical indices were similar (p>0.05) across the treatments. Betaine hydrochloride can be included in the diets of broiler chicks up to 4 g/kg diet to improve growth performance without any detrimental effect on growth, haematological and serum biochemicals.

Keywords: Betaine Hydrochloride, chicks, growth, heat stress, serum biochemical

Introduction

The thermoneutral zone for poultry is 18°C–24°C in the tropics and 12°C–26°C in the temperate zones, but this often gets exceeded in the tropics, resulting in heat stress (Holik, 2009; Dei and Bumbie, 2011). Extremes of ambient temperature is an important stressor that confronts poultry in many regions of the world and large economic losses can occur because of mortality and decreased production (Altan *et al*., 2000). Modern broiler chicken production systems are strongly susceptible to stressors such as heat which induce immunosuppression and increase susceptibility to infectious diseases (Quinteiro-Filho *et al.,* 2012, Gomes *et al*., 2014, Calefi *et al*., 2014). Combating heat stress remains a challenge for the broiler chicken industry in the tropics, and dietary measures amongst other things can be used to ameliorate heat stress to achieve optimum performance. Betaine is a naturally-occurring product present in relatively large quantities in sugar beet and aquatic invertebrates, but not present in most animal feedstuffs (Wang *et al*., 2004). As a by-product of sugar beet processing, betaine is commercially available as a feed additive (Eklund *et al*., 2005). Betaine has two primary metabolic roles, it is a methyl group donor and presumably reduces the requirement for other methyl-group donors, such as methionine and choline; it is also an osmolyte that assists in cellular water homeostasis (Klasing *et al*., 2002). In biological systems, naturally occurring Betaine serves as an organic osmolyte. Osmolytes are substances synthesized or taken up from the environment by cells for protection against osmotic stress, drought, high salinity, and high temperature; but also has a positive effect on oxidative stress (DePace and Colombo, 2019). This study was conducted to evaluate the protective effect of Betaine Hydrochloride supplementation on thermoregulatory, growth, haematological and biochemical

indices of broiler chicks exposed to high ambient temperatures.

Materials and methods

Experimental site, diets and management

The research was carried out at the Poultry Unit of the Department of Animal Science Teaching and Research Farm, Faculty of Agriculture, Ahmadu Bello University, Zaria. One hundred and eighty, one day old Hubbard breed of broiler chicks were assigned to four treatments in a completely randomized design (CRD). In each treatment, there were forty-five chicks assigned randomly to three replicates with fifteen birds in each replicate. The experimental diets consisted of four diets with varying inclusion levels of Betaine Hydrochloride (0, 1.5, 3.0 and 4.5 g/kg feed), respectively. The average temperature recorded during the experiment was 38.2 °C. Table 1 shows the composition of the experimental diets formulated to meet the requirement of NRC (1994).

Table 1: Composition of broiler chicks starter diets

	Inclusion Levels Of Betaine Hydrochloride (g/kg)			
Ingredients (%)	0	1.5	3	4.5
Maize	55.0	55.0	55.0	55.0
Groundnut cake	20.5	20.5	20.5	20.5
Soybean cake	20.3	20.3	20.3	20.3
Bone meal	3.0	3.0	3.0	3.0
Limestone	0.3	0.3	0.3	0.3
Common salt	0.3	0.3	0.3	0.3
Methionine	0.35	0.35	0.35	0.35
Vitamin premix	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**
Calculated Analysis				
Metabolizable Energy (Kcal/kg)	2889	2889	2889	2889
Crude Protein (%)	23.0	23.0	23.0	23.0
Crude Fibre (%)	4.37	4.37	4.37	4.37
Ether Extract (%)	4.79	4.79	4.79	4.79
Calcium (%)	1.27	1.27	1.27	1.27
Available Phosphorus (%)	0.59	0.59	0.59	0.59
Lysine (%)	1.03	1.03	1.03	1.03
Methionine (%)	0.68	0.68	0.68	0.68
Ash (%)	1.65	1.65	1.65	1.65

Data collection

The chicks were weighed and randomly assigned to treatments on arrival and weighed weekly thereafter. Feed intake, feed leftover and weight gain were recorded weekly for three weeks. Thermoregulatory parameters were determined twice a week, heart rate was measured by the number of heart contractions per minute, and was monitored using a stop watch. Rectal temperature was measured using a digital clinical thermometer by inserting the tip into the rectum with an accuracy of ±0.1 °C (Yahav and McMurtry, 2001). Blood samples were collected from three birds of average weight per replicate at four weeks of age.

Haematological and serum biochemical analysis

Three birds of average size in each replicate were sampled and 3 mLs of blood were collected from each bird (2 mLs in plain blood collection tube and 1 mL in EDTA blood collection tubes). The blood samples

(0.5 mL) in the EDTA bottles were used for haematological analyses and the uncoagulated blood samples were used for determination of haemoglobin (Hb) concentration, packed cell volume (PCV) using cyanmethaemoglobin and Wintrobe microhaematocrit methods respectively *(Coles, 1986)* and total protein (Tp). Determination of Aspartate aminotransaminase, Alanine aminotransaminase and alkaline phosphatase was conducted using the enzyme analytical kits (Reitman and Frankel, 1957). The analyses were conducted at the Department of Chemical Pathology, Ahmadu Bello University Teaching Hospital, Shika.

Data analysis

All the data obtained were subjected to analysis of variance (ANOVA) and significant differences were separated using Duncan's Multiple Range Test (SAS, 2000).

Results and discussion

The result of the effect of Betaine Hydrochloride supplementation on thermoregulatory parameters is shown on Table 2. There were no differences ($p>0.05$) in the rectal temperature and heart rate of the birds across the treatments though rectal temperature and heart rate decreased numerically in birds fed Betaine Hydrochloride diets. This is an indication of the ameliorative effect of Betaine Hydrochloride on broilers subjected to heat stress.

Table 2: Effect of betaine hydrochloride on thermoregulatory parameters in broiler chickens

	Level of Betaine Hydrochloride (g/kg)					
Parameters	0	1.5	3.0	4.5	SEM	Pr>f
RT (^{O}C)	41.63	41.53	41.50	41.53	0.03	0.37
HR (bpm)	289.50	284.25	287.25	282.50	111.92	0.38

Table 3 shows the effect of Betaine Hydrochloride supplementation on the growth performance of broiler chicks. Birds fed 1.5 and 4.5 g/kg diet Betaine Hydrochloride had better ($p>0.05$) feed intake, weight gain and feed conversion ratio than birds fed control and 3 g/kg diet Betaine hydrochloride. The result shows that inclusion of Betaine Hydrochloride improved the performance of the birds. Attia *et al.* (2009) and Singh *et al*. (2015) also reported improved weight gain and feed conversion in broilers subjected to heat stress. Post mortem report stated that the poor performance observed in birds fed 3 g/kg diet was due to some mineral deficiency.

Table 3: Effects of betaine hydrochloride supplementation on growth performance of broiler chicks

Parameters	Level of Betaine Hydrochloride (g/kg)					
	0	1.5	3.0	4.5	SEM	P Value
Initial Wt (g)	40.87	40.87	40.87	40.43	0.38	0.859
Feed Intake (g)	437.00^{b}	461.40^{a}	438.57^{b}	467.47^{a}	14.529	0.498
Final wt (g)	292.23^{b}	321.43^{a}	296.80^{b}	327.43^{a}	9.524	0.129
Wt gain (g)	251.37^{b}	280.57^{a}	250.37^{b}	287.00^{a}	9.594	0.059
FCR	1.74^{b}	1.65^{a}	1.75^{b}	1.63^{a}	0.05	0.429

^{ab} means with different superscripts along the row differ significantly ($p<0.05$). Wt- weight

Table 4 shows the effect of Betaine Hydrochloride supplementation on the haematological indices of Broiler chicks. The result shows that the white blood cell count (WBC), red blood cell count (RBC) and haemoglobin (Hb) were similar ($p>0.05$) across the treatments, an indication that Betaine Hydrochloride had

no adverse effect on WBC, RBC and haemoglobin of the broiler chicks. Haemoglobin values obtained are within the range (10.15-11.43g/dl reported by Agboola et al. (2013). The RBC values are slighty lower than 2.88-4.12 x 10^{12}/L reported by Campbell *et al*. (2003). This might be due to individual differences in the broilers.

Table 4: Effect of betaine hydrochloride on haematological indices of broiler chicks

	Levels of Betaine Hydrochloride (g/kg)					
Parameters	**0**	**1.5**	**3.0**	**4.5**	**SEM**	**Pr>F**
Hb (g/dL)	10.64	10.71	11.50	10.26	0.837	0.4650
RBC (10^{12}/L)	2.46	2.58	2.84	2.42	0.214	0.1855
WBC ($\times10^{9}$/L)	82.61	78.81	84.67	73.93	7.09	0.4063

Hb- Haemoglogin; WBC- White blood cell; RBC- Red blood cell

Table 5 shows that blood glucose, total protein, albumin, total cholesterol and triglycerides were similar ($p>0.05$) across the treatments. Blood glucose (13.80-15.53 mmol/L), total protein (62.67-64.56 g/l) and albumin (33.78-35.0 g/l) obtained were within the normal range (Clinical Diagnostic Division, 1990). The result of the broilers serum biochemicals is an indication that the parameters were not negatively affected by heat stress and administration of Betaine. The values for cholesterol (4.47-4.84mmol/L) obtained was lower than the normal range (7.74-17.82mmol/L) reported by Clinical Diagnostic Division (1990) and Dikmen and Sahan (2007). Generally, cholesterol is lower in chicks than adults, the difference might also be due to breed differences.

Table 5: Effects of Betaine Hydrochloride on Serum Biochemical Indices in Broiler Chicks

	Level of Betaine Hydrochloride (g/kg)					
Parameters	**0**	**1.5**	**3.0**	**4.5**	**SEM**	**Pr>F**
Glucose(mmol/L)	13.80	14.79	15.53	14.24	1.92	0.80
TP (g/l)	63.78	62.67	62.78	64.56	2.56	0.84
Albumin (g/l)	34.00	33.78	34.78	35.00	2.19	0.92
Chol (mmol/L)	4.64	4.47	4.83	4.54	0.38	0.76
TG (mmol/L)	0.88	0.77	0.62	0.80	0.38	0.18

[ab] means with different superscripts along the row differ significantly ($p<0.05$). TP - Total Protein, Chol - Cholesterol, TG- Triglycerides

Conclusion

Betaine hydrochloride (4 g/kg diet) can be included in the diets of broiler chicks to improve performance without any detrimental effect on thermoregulatory, growth, haematological and biochemical blood indices.

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