

EFFECT OF DIFFERENT LEVELS OF HONEY ON PHYSIOLOGICAL, GROWTH AND CARCASS TRAITS OF BROILER CHICKENS DURING DRY SEASON

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Received January 13, 2016; accepted May 17, 2016.
Delo je prispelo 13. januarja 2016, sprejeto 17. maja 2016.

Effect of different levels of honey on physiological, growth and carcass traits of broiler chickens during dry season

The objective of this trial was to investigate the effect of different levels of honey in drinking water on the responses of broiler chickens during dry season in hot humid tropics. Three hundred Oba Marshall broiler chicks were used for this study. The day-old chicks were randomly assigned to five treatment groups with each treatment having four replicates of 15 birds. The first 4 treatment groups were daily supplied drinking water without honey (0H), with 20 ml (20H), 40 ml (40H) and 60 ml (60H) of honey per liter of water. The fifth group received drinking water supplemented with 500 mg vitamin C per liter of water (C). Records on daily weight gain (WG) and feed intake (FI) were taken. Feed conversion ratio (FCR) was calculated as the ratio of gain to feed consumed. The supplementation of honey in the drinking water for broiler chickens in 60H during hot dry season in the hot humid tropics improved some stress indices, body weight gain and relative spleen weight.

Key words: poultry; broiler chickens; animal nutrition; honey; growth; physiological traits; carcass traits; hot dry season

1 INTRODUCTION

Broiler chicken production plays a vital role in food security for the fast increasing human population in Nigeria due to the short production cycle, high feed efficiency and growth rate of the birds. The birds are however faced with the challenges of coping with the ever changing elements of weather, especially the ambient temperature typically during growing-finishing phase in the tropics. This is partly due to the fact that the tropics and sub-tropics are faced with the challenge of high am-

Učinek dodajanja različnih količin medu na fiziološke, rastne in klavne lastnosti pitovnih piščancev v sušnih razmerah

Cilj raziskave je bil preučiti vpliv dodajanja različnih količin medu v pitno vodo pitovnih piščancev med vročim in suhim obdobjem v vročih in vlažnih tropih. Za to študijo smo uporabili 300 pitovnih piščancev provenience Oba Marshall. Enodnevni piščanci so bili naključno razporejeni v pet poskusnih skupin, s štirimi ponovitvami s po 15 piščanci v vsaki skupini. V prvih štirih skupinah so piščanci dobivali pitno vodo brez medu (0H), z 20 ml (20H), 40 ml (40H) in 60 ml (60H) medu na liter vode. Peta skupina je dobivala pitno vodo, dopolnjeno s 500 mg vitamina C na liter vode (C). Merili smo dnevne priraste (WG) in količino zaužite krme (FI). Izkoriščanje krme (FCR) smo izračunali kot razmerje med prirastom in porabo krme. Dodatek medu v pitni vodi za pitovne piščance v skupini 60H v vročem in sušnem obdobju v vročih in vlažnih tropih je izboljšal nekatere pokazatelje stresa, pitovne lastnosti in povečal relativno maso vranice.

Gljučne besede: perutnina; pitovni piščanci; prehrana živali; med; rast; fiziološke lastnosti; klavne lastnosti; vroče sušno obdobje

bient temperature and high humidity which have been reported to affect the productive performance of chickens (Ahmad et al., 2005; Dagher, 2008). Great losses are being encountered in broiler production in Nigeria every year due to the effect of heat-stress. The loss is attributed to the fact that the birds have rapid metabolism, high body temperature and no sweat gland (Abioja, 2010).

In South Western Nigeria, environmental temperature is often higher than the recommended temperature of 18–21 °C (Charles et al., 2002) for optimal productivity of growing broiler chickens particularly during the

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dry season which usually occurs between the month of November and March. As a result of this peculiarity, a passable and appropriate measures that can ameliorate the adverse effect of the environmental factors to the barest minimum to ensure optimum broiler production in the hot dry season are essential.

Some of the methods recommended to alleviate the adverse effects of high ambient temperature including housing, ventilation, air conditioning and cooling systems are now issues that are probably applicable on a regional basis (Armstrong et al., 1999; Yalcin et al., 2001). However, some of these methods cannot be applied in developing countries including Nigeria because of their impracticability and high cost. Instead, nutritional manipulation with its low cost is a common approach in poultry production (Austic, 1985; Leeson, 1986; Shane, 1988). Results from various studies (Sayed and Shoeib, 1996; Yahav and McMurty, 2001; Curca et al., 2004; Aradas et al., 2005; Gonzalez-Esquerra and Leeson, 2006; Ramnath et al., 2008; Zhang et al., 2009; Abioja et al., 2011) on several measures taken to abridge the effect of heat stress in poultry with the use of several therapeutic agents remain inconclusive. Moreover, several natural substances that are rich in antioxidants have also been used on heat-stressed chickens. These include bee pollen (Wang et al., 2005), ginger root (Zhang et al., 2009), etc. The use of honey has however received a meagre attention.

Honey is a complex product and contains natural anti-oxidants. Antioxidants play a major role in the protection of cells from reactive oxygen species (ROS) by reducing chemical radicals and preventing the process of lipid peroxidation (Yu, 1994). When compared to synthetic vitamin C that is conventionally used, honey is more readily available while vitamin C may not be readily available especially to the local farmers. Honey is a good example of natural substance that contains phytochemicals such as vitamin C, thiamine, riboflavin, pyridoxine, pantothenic acid, nicotinic acid, phenolic compounds, and enzymes glucose oxidase, catalase, and peroxidase. Honey has been used by man for several purposes especially as an antioxidant. However, there is a dearth of reports on the use of honey in poultry production. Our previous study (Abioja et al., 2010) on the inclusion levels of honey (0, 10, 20 ml) in drinking water of broiler chickens neither affected the growth nor reduced the body temperature while there was no change in the physiological responses and haematology on adding 0 and 10 ml of honey but slight change in physiological responses occurs on adding 20 ml of honey. Therefore this trial was carried out to determine if an increase in the inclusion levels of honey (20, 40, 60 mls) in drinking water of broiler chickens from day-old to 8 weeks old would in-

fluence more changes in the physiological responses and also bring about the possibility of better performance of broiler chickens. This study therefore aimed at determining the effect of different levels of honey on the physiological response of broiler chicken during hot-dry season

2 MATERIALS AND METHODS

2.1 EXPERIMENTAL SITE

The experiment was carried out at the poultry unit of Directorate of University Farms (DUFARMS) and the laboratory, Federal University of Agriculture, Abeokuta (FUNAAB). The University is located on latitude 7°10'N, longitude 3°2'E and altitude 76 m above sea level. It lies between South-Western part of Nigeria with a prevailing tropical climate with a mean annual rainfall of 1,037 mm, and annual mean temperature and relative humidity of 34 °C and 82 %, respectively (Amujoyegbe et al., 2008). The vegetation in the University represents the inter-phase between the tropical rain forest and the derived savannah. The average maximum and minimum temperature during the period of the experiment was 35.5 °C and 23.8 °C, respectively while relative humidity was 92 %.

2.2 EXPERIMENTAL ANIMALS AND PROCEDURE

Three hundred Oba Marshall broiler day-old chicks purchased from a reputable hatchery at one day of age were used for this study. The brooding temperature was maintained at 35 °C for the first two days then decreased gradually until 21 days of age. The light regime was 23L:1D. The vaccination schedule for commercial broiler chickens was followed. The chicks were randomly assigned to five treatment groups with each treatment having four replicates of 15 birds in a completely randomized design at day 21. The first 4 treatment groups were daily supplied drinking water without honey (0H), with 20 ml (20H), 40 ml (40H) and 60 ml (60H) of honey per liter of water. The fifth group received drinking water supplemented with 500 mg vitamin C per liter of water (C).

The birds were kept on deep-litter floor in an open-sided poultry house. The birds were floor-brooded for three weeks on wood-shavings. Additional sources of heat were provided during the brooding period. The chicks were fed *ad libitum* with standard starter mash and thereafter with finisher mash. Water at ambient temperature was supplied *ad libitum* throughout the period of the experiment. The composition of the diet is shown in Table 1.

2.3 DATA COLLECTION

2.3.1 GROWTH PERFORMANCE

Bodyweight of the birds in each replicate were monitored using a sensitive scale every week during the experiment. Records on daily weight gain (WG) and feed intake (FI) were taken. Feed conversion ratio (FCR) was calculated as the ratio of gain to feed consumed.

2.3.2 RELATIVE WEIGHTS OF ORGANS

At 56 days of age, 2 birds per replicate were slaughtered. The birds were dissected and the weights of liver, kidney, lungs, spleen, breast meat, gizzard, drum stick, shank, thigh, tibia, small intestine, proventriculus, ab-

Table 1: Composition of diets for broiler (starter and finisher phases)

Preglednica 1: Sestava popolne krmne mešanice za pitovne piščance (začetna in končna faza pitanja)

Ingredient	Starter phase	Finisher phase
Maize	46.00	50.00
Soybean meal	18.50	12.00
Groundnut cake	15.00	11.00
Fish meal	2.00	2.00
Wheat offal	12.45	19.05
Bone meal	2.00	2.00
Oyster shell	3.00	3.00
Salt	0.25	0.25
Premix	0.25	0.25
Methionine	0.30	0.25
Lysine	0.25	0.20
	100	100
Calculated		
Crude protein (%)	23.05	19.91
M.E (Kcal/kg)	2816	2809.6
Ether extract (%)	3.93	3.89
Crude fiber (%)	3.67	3.79
Calcium (%)	1.75	1.74
Phosphorus (%)	0.43	0.41

* 1 kg of premix contains: Vitamin A – 10,000,000 IU; Vitamin D3 – 2,000,000; Vitamin E – 20,000 IU; Vitamin K – 2,250 mg; Thiamine B1 – 1,750 mg; Riboflavin B2 – 5,000 mg; Pyridoxine B6 – 2,750 mg; Niacin – 27,500 mg; Vitamin B12 – 15 mg; Pantothenic acid – 7,500 mg; Folic acid – 7,500 mg; Biotin – 50 mg; Choline chloride – 400 g; Antioxidant – 125 g; Magnesium – 80 g; Zinc – 50 mg; Iron – 20 g; Copper – 5 g; Iodine – 1.2 g; Selenium – 200 mg; Cobalt – 200 mg

dominal fat pad, gastrointestinal tract, bursa of *Fabricius*, thymus, heart were taken and relative weights were determined as a percentage of bird's bodyweights.

2.3.3 HAEMATOLOGY AND SERUM ANALYSIS

Blood samples were collected from two randomly picked birds from each replicate once a week via brachial vein into ethylene diamine tetra acetic acid (EDTA) anticoagulant and immediately mixed gently to avoid clotting. Blood samples were analysed for haemoglobin (Hb), Packed Cell Volume (PCV), Total Erythrocyte Count (TEC), Total Leukocyte Count (TLC) and Differential Leukocyte Count (DLC). Hb estimation was determined by cyanmethaemoglobin method and PCV by microhematocrit method (Bernard et al., 2000). TEC and TLC were determined using Neubaur's hemocytometer and Toluidine blue (0.015 %) saline as diluent (Brar et al., 2002). The blood films stained with Wright's stain (Benjamin, 1985) was studied for DLC. Mean cell volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) were calculated (Stockham and Scott, 2002).

The blood samples were also analyzed for serum metabolites including serum total protein, albumin, globulin and creatinine. Serum glucose was determined colorimetrically using the method described by Braham and Trinder (1969). The total serum protein was determined according to the method of Colowick and Kaplan (1955) while serum albumin and globulin was determined using bromocresol purple method of Varley et al., (1980). Serum corticosterone was determined using radio immunoassay (RIA) technique as described by Darras et al. (1992).

2.4 STATISTICAL ANALYSIS

All data collected were subjected to analysis of variance using the procedure of SAS (1999). Significantly different means were compared using Duncan Multiple Range Test.

3 RESULTS

3.1 SERUM CHEMISTRY

The effect of different levels of honey on serum parameters in broiler chickens at finisher phase during hot-dry season is shown in Table 2. The blood glucose level in 0H and 60H treatment groups were similar but higher than those birds in 40H, 20H and C treatment groups.

Table 2: Effect of different levels of honey on serum parameters of broiler chickens at finisher phase**Preglednica 2:** Učinek različnih ravni dodajanja medu na parametre krvnega seruma pitovnih piščancev v končnem obdobju pitanja

Parameters	0H	20H	40H	60H	Vit C	SEM
Glucose (mg/dl)	124.65 ^a	101.90 ^b	107.95 ^b	125.9 ^a	95.8 ^b	5.13
Total Protein(g/l)	52.45 ^b	52.70 ^b	58.55 ^{ab}	61.15 ^a	63.65 ^a	1.62
Albumin (g/l)	36.05	34.55	39.45	39.05	41.10	1.20
Globulin (g/l)	16.40	18.15	19.10	21.60	22.55	0.99
Triglyceride(mg/dl)	145.80 ^c	123.20 ^c	148.25 ^c	226.80 ^a	185.70 ^b	12.50
AST (IU/l)	145.80 ^a	112.45 ^b	135.60 ^{ab}	130.85 ^{ab}	140.40 ^a	4.40
ALT (IU/l)	36.70 ^{ab}	36.40 ^{ab}	21.85 ^b	45.75 ^a	57.45 ^a	4.38
Creatine kinase (IU/l)	129.15 ^{ab}	107.90 ^{cd}	136.15 ^a	119.35 ^{bc}	100.00 ^d	4.63
Corticosterone (ng/mL)	237.50 ^a	157.00 ^c	198.50 ^b	203.50 ^b	189.50 ^b	8.75

^{a, b, c} Means within a row with different superscripts differ significantly ($p < 0.05$). AST – Aspartate amino-transferase; ALT – Alanine amino-transferase

Moreover, birds on 40H, 20H and C had also similar blood glucose levels. The level of total protein in the birds in C and 60H treatment groups were similar but significantly higher ($p < 0.05$) than in birds in 20H and 0H treatments while those of 40H, 20H and 0H were similar. The triglyceride level of 60H was significantly higher than those of other treatment groups. Birds in 40H, 0H, 20H treatment groups had similar level of triglyceride but lower than that of C treatment group. Birds in 0H and C treatment group were similar but higher in aspartate amino-transferase level than those of the birds in 20H. Birds in C and 60H treatment group were higher in alanine amino-transferase level than those of 40H treatment group. Also 0H 20H, 60H

and C treatment groups were similar in alanine amino-transferase levels. Creatine kinase level in 40H was significantly higher than those of other treatment groups apart from the birds in 0H which had similar levels. Birds in C treatment group had similar level of creatine kinase than those in 20H but lower than the birds in the other treatment groups. Birds in 0H had a significantly higher level of creatinine kinase than those of 20H and C treatment groups. Birds in 0H had higher ($p < 0.05$) level of serum corticosterone than those of the other treatment groups. The level of serum corticosterone recorded in the birds in 20H treatment group was lower ($p < 0.05$) than those of 0H, 60H, 40H and C treatment group.

Table 3: Effect of different levels of honey on haematological parameters of broiler chickens at finisher phase during hot-dry season**Preglednica 3:** Učinek dodajanja medu na hematološke parametre pitovnih piščancev v končni fazi pitanja v vročem in suhem obdobju

Parameters	Level of honey and vitamin C					SEM
	0H	20H	40H	60H	Vit C	
PCV (%)	30.50	27.50	32.00	32.50	37.00	1.57
Haemoglobin (G/Dl)	9.85	8.80	10.55	10.20	11.35	0.44
Red blood cell	2.60	2.30	2.75	2.80	3.15	0.15
White blood cell	10.85	10.20	11.20	10.00	9.80	0.29
Heterophil	30.00	32.00	36.50	30.50	35.50	1.80
Lymphocyte (%)	70.00	66.00	63.50	68.50	63.50	1.85
Eosinophil (%)	0.00	0.50	0.00	0.00	0.50	0.13
Basophil (%)	0.00	0.50	0.00	0.00	0.00	0.10
Monocyte (%)	0.00	1.00	0.00	1.00	0.50	0.27
HL	0.43	0.51	0.58	0.45	0.56	0.04
MCH (μg)	38.03	38.18	38.26	37.13	36.32	0.95
MCV (μ^3)	117.85	119.31	116.39	117.25	118.21	2.64
MCHC (%)	32.33	32.00	32.87	31.61	30.70	0.35

MCV – Mean corpuscular volume, MCH – Mean corpuscular haemoglobin, MCHC – Mean Corpuscular haemoglobin concentration, HL – Heterophil : lymphocyte ratio, PCV – Packed cell volume

Table 3 shows the effect of different levels of honey on haematological parameters of broiler chickens at finisher phase during the hot-dry season. There was no significant effect of different levels of honey on the haematological parameters of the birds among the treatment groups at the finisher phase.

3.2 GROWTH PERFORMANCE

Effect of different levels of honey on the performance of broiler chickens is presented in Table 4. The weight gain of the birds in 60H treatment group was higher than those of the birds in the other treatment groups. The birds in 20H treatment group had similar-weight gains as those of 40H and C groups. The weight gain in 0H was lower than those of the other treatment groups. Also the feed intake of the birds in 0H was lower than those of the other treatment groups whose values were similar. The feed conversion ratio was similar across the treatment groups ($p > 0.05$).

3.3 RELATIVE WEIGHTS OF ORGANS

Effect of different levels of honey on the relative weights of organs of broiler chickens is presented in Table 5. The body weights of the birds in 20H and 40H were significantly higher ($p < 0.05$) than that of 0H group. The weights of the birds in 60H and C group were similar but higher than the weights recorded in the other treatment groups. The relative weights of liver in broiler chickens in 0H group were significantly higher ($p < 0.05$) than those of other treatment groups. The liver relative weights of the birds in 40H group were higher than those of 20H, 60H and C group. The relative weights of kidney of the birds in 40H, 60H and C group were similar but significantly higher ($p < 0.05$) than those of 0H and 20H. The relative weight of the lungs of the birds in 0H was sig-

nificantly higher than those of other treatment groups. The heart weights of the birds in 0H group were significantly higher ($p < 0.05$) than those of the other treatment groups. The relative weight of small intestine in broiler chicken of 0H group was significantly higher ($p < 0.05$) than those of the other treatment groups. The birds in 40H group had a significantly higher ($p < 0.05$) weights than those of 60H and C treatment groups. The relative weight of proventriculus of the birds in 0H group was significantly higher ($p < 0.05$) than those of the other treatment groups. The relative weights of empty gizzard in 60H and C group were similar but significantly higher ($p < 0.05$) than that of 40H group whose value was also higher than that of 20H group. The relative weights of breast meat of the birds in 20H and 40H group were similar but significantly higher ($p < 0.05$) than those of 0H, 60H and C treatment groups whose values were similar. The relative weight of thigh in 0H group was significantly higher ($p < 0.05$) than those of the other treatment groups. The values recorded for the birds in 40H were higher than those of the birds in 60H and C treatment groups whose values were similar. The shank relative weight recorded in the birds in 60H was higher than in those of the other treatments. The drum stick weight was also higher in the birds in 60H than the birds in the other treatment groups. The value for 40H was also higher than those of 0H and C treatment groups. The GIT relative weights recorded in the birds in 60H were higher than those of the other treatment groups. The values in 20H and 40H were comparable but higher than those of 0H and C treatment groups.

The relative weights of tibia in 40H were comparable to those of 60H and C treatment groups but significantly higher ($p < 0.05$) than those of 0H and 20H groups, which were similar to those of 60H and C treatment groups.

Effect of different levels of honey on the relative weights of lymphoid organs of broiler chickens at finisher phase during hot-dry season is presented in Table 6. The relative weight of thymus of the birds in 40H was similar

Table 4: Effect of different levels of honey on performance of broiler chickens at finisher phase

Preglednica 4: Učinek različnih ravni dodanega medu na proizvodne lastnosti pitovnih piščancev v končni fazi pitanja

Parameters	Levels of inclusion honey				Vit C	SEM
	0H	20H	40H	60H		
Initial body weight at 4wks (g)	590.52	588.28	586.69	585.41	587.96	2.04
Final body weight (g)	1785.10 ^d	1839.44 ^c	1855.45 ^b	1887.62 ^a	1828.36 ^c	7.89
Weight gain (g)	1194.59 ^d	1251.16 ^{bc}	1268.76 ^b	1302.21 ^a	1240.42 ^c	8.59
Feed intake (g)	2783.10 ^b	2992.05 ^a	2973.93 ^a	3028.06 ^a	2963.39 ^a	26.00
Feed conversion ratio	2.32	2.39	2.34	2.32	2.39	0.01
Mortality	0	0	0	0	0	

^{a, b, c, d} Means within rows with different superscripts differ significantly ($p < 0.05$)

Table 5: Effect of different levels of honey on the relative weight of organs of broiler chickens at finisher phase during hot-dry season**Preglednica 5:** Učinek dodajanja različnih količin medu na relativno maso organov pitovnih piščancev v končni fazi pitanja v vročem in suhem obdobju

Parameters	Level of honey and vitamin C					SEM
	0H	20H	40H	60H	Vit C	
Body weight (kg)	1.70 ^c	2.03 ^b	2.05 ^b	2.25 ^a	2.35 ^a	0.077
Liver (%)	2.60 ^a	2.03 ^c	2.27 ^b	2.11 ^c	2.05 ^c	0.072
Kidney (%)	0.12 ^b	0.14 ^b	0.16 ^a	0.16 ^a	0.16 ^a	0.006
Lungs (%)	0.54 ^a	0.51 ^b	0.49 ^{bc}	0.48 ^{cd}	0.46 ^d	0.010
Heart (%)	0.72 ^a	0.42 ^b	0.43 ^b	0.46 ^b	0.46 ^b	0.038
Small intestine (%)	3.08 ^a	2.73 ^{bc}	2.87 ^b	2.66 ^{cd}	2.55 ^d	0.062
Proventriculus (%)	2.66 ^a	2.39 ^b	2.44 ^b	2.25 ^c	2.17 ^c	0.058
Empty gizzard (%)	0.25 ^d	2.14 ^c	2.31 ^b	2.44 ^a	2.43 ^a	0.280
Abdominal fat (%)	1.62	1.58	1.69	1.63	1.58	0.018
Breast meat (%)	17.76 ^b	19.10 ^a	19.15 ^a	17.61 ^b	16.95 ^b	0.312
Thigh (%)	18.88 ^a	9.15 ^d	12.23 ^b	11.17 ^c	10.72 ^c	1.129
Shank (%)	2.73 ^b	2.74 ^b	2.95 ^b	5.08 ^a	2.648 ^b	0.312
Drum stick (%)	4.53 ^{cd}	4.74 ^{bc}	4.93 ^b	5.65 ^a	4.35 ^d	0.153
Tibia (%)	0.788 ^b	0.803 ^b	0.94 ^a	0.88 ^{ab}	0.87 ^{ab}	0.020
GIT (%)	15.505 ^c	16.66 ^b	16.92 ^b	18.85 ^a	14.93 ^c	0.463

^{a, b, c} Means within a row with different superscripts differ significantly ($p < 0.05$)

to that of 60H but significantly higher than those of 20H, 0H and C treatment groups. However the relative weights of thymus in broiler chicken of 0H, 20H and C treatment groups were similar. The relative weights of spleen of the birds in 40H, 60H and C group were similar but significantly higher ($p < 0.05$) than that of 0H and 20H. The weights recorded in the birds in 20H were significantly higher ($p < 0.05$) than that of 0H.

4 DISCUSSION

Enhanced levels of serum ALT, AST and LDH are used as indicators of liver damage (Ozaki et al., 1995). In

the present study, the activity of AST and ALT enzymes did not follow a consistent trend with the inclusion of honey in the drinking water of broilers during stress. This supports the findings of Hosseini-Vashan et al. (2012) who reported that turmeric powder depressed AST in heat stressed broiler due to the antioxidant *curcumin* which is a component of the additive. The similarity in levels of serum albumin and globulin in the birds offered different levels of honey and ascorbic acid in the present study differs from the findings of Al-Shanti (2005) who found that supplementing heat stressed broilers with 1 g vitamin C/l drinking water had no effect on blood albumin and globulin

The present study showed that inclusion of honey at

Table 6: Effect of different levels of honey on the relative weight of lymphoid organs of broiler chickens at finisher phase during hot-dry season**Preglednica 6:** Učinek dodajanja različnih količin medu na relativno maso limfatičnih organov pitovnih piščancev v končni fazi pitanja v vročem in suhem obdobju

Parameters	Level of honey and vitamin C					SEM
	0H	20H	40H	60H	Vit C	
Spleen (%)	0.017 ^c	0.029 ^b	0.038 ^a	0.383 ^a	0.039 ^a	0.075
Thymus (%)	3.082 ^{bc}	3.867 ^b	4.019 ^a	3.882 ^{ab}	3.831 ^b	0.035
Bursa (%)	0.560	0.545	0.576	0.562	0.553	0.005

^{a, b, c} Means within a row with different superscripts differ significantly ($p < 0.05$)

60 ml/l improved the total serum protein. Similar reports were obtained by Giurgea et al. (1981) who indicated that daily administration of propolis extract to chickens had a significant effect on the serum. On the contrary, Al-Shanti (2005) reported that supplementing vitamin C to the heat-stressed broilers had no effect on blood total protein. This may be due to the difference in the strains of the birds used for the experiment. The decrease in the serum glucose levels of the birds offered honey at 20 and 40 ml/l and vitamin C in this trial corroborates the findings of Hazim et al. (2001) who reported an improvement in the blood glucose level of broiler birds whose diets were supplemented with ascorbic acid (at 0, 150, 300 and 450 mg / kg diet) during summer months.

The creatine kinase levels of the birds offered honey was not elevated compared with the birds offered ordinary water in this study. The lower levels observed in the birds offered 20 ml/l and vitamin C in the present study may indicate that honey supplementation did not impair the function of the kidney. Also the corticosterone levels of broiler chickens supplemented with honey were lower than in the 0H group. This suggests that addition of honey up to 60H helped in ameliorating heat stress in broiler chickens compared to 0H group. This is in agreement with previous studies (Mckee and Hurrison, 1995; Mahmoud et al., 2004) which reported that the improved performance resulting from the use of ascorbic acid was associated with the suppressed stress response indicated by reduction in plasma corticosterone level. Stressors such as high environmental temperature induce a cascade of neural and hormonal events, beginning with hypothalamic stimulation and the production of corticotrophin-releasing factor, which stimulates the anterior pituitary to produce adrenocorticotrophic hormone, and ending with stimulation of adrenal cortical tissue by adrenocorticotrophic hormone to increase the production and release of corticosteroids, primarily corticosterone in birds (Siegel, 1995). The reduction in the levels of serum corticosterone in birds offered varying levels of honey in this study, implies that addition of honey in the drinking water of broiler chickens had an ameliorative effect on the birds and they were able to cope with the hot dry season and to perform better than the birds in the control group.

The higher body weights recorded in the birds in 60H in the present study are in conformity with the report of Gross (1988) who reported that dietary vitamin C improved growth performance in broilers. The higher weights of birds associated with higher dosage of honey beyond 20 ml in this study suggest that this level contained potent antioxidant which was beneficial to the birds during stress. The present observation is an improvement on our previous findings (Abioja et al., 2010) where it was reported that there was no significant differ-

ence in the weights of broiler chickens offered honey up to 20 ml/l in drinking water. This could therefore be explained by the fact the doses of honey (20 ml/l of water) administered in the previous study was not high enough to cause a positive effect. The higher feed intake observed in the birds offered dietary vitamin C and honey in the present study corresponds to the report of Bonomi et al. (1976) who found an increase in feed intake when propolis was fed to laying hens.

Addition of honey to the drinking water of heat-stressed birds had no significant effect on PCV, RBC, WBC, heterophil, lymphocyte, eosinophil, monocyte, basophil, MCH, MCV, MCHC, haemoglobin and HL. The PCV values of all the experimental birds were within the normal range for chickens (24.9–45.2 %) as reported by Mitruka et al. (1997). Also all HB, MCV, MCH and MCHC values of all experimental birds were within the normal range for chickens (7–13, 90–140, 33–47 and 26–35, respectively).

This study has shown that relative weights of tibia were improved by addition of honey to the drinking water of broiler chickens especially at high dose (40H). This might be adduced to the improvement in calcium metabolism of the birds. The higher relative weight of the tibiae is concurrent with the findings of Abioja et al. (2012) who observed that addition of honey up to 20 ml/l of water for broiler chickens improved tibiae weight. The present study has further validated the fact that a dose higher than 20 ml/l is beneficial to the birds during hot dry season in Nigeria.

The relative weight of thymus was increased by the addition of 40 ml honey/l of water. Heat stress has been reported to inhibit immune functions in chickens (Curca et al. (2003); Mashaly et al. (2004)). Surgical removal of thymus has been used to demonstrate its immunologic role (Panigrahi et al., 1971). Efficacy of Sb-Asper-C, a combined ascorbic acid and acetylsalicylic acid treatment in reducing the effects of heat stress was tested in broilers by Anwar et al. (2004). The authors reported that the treatment increased the ratio of thymus to body weight. The thymus of heat-stressed chickens not supplemented with Sb-Asper-C was atrophied. The increase in the thymus in the present study supports the findings of Abioja et al. (2012) that honey up to 20 ml per liter of water reduces the effect of heat stress on thymus.

Increased liver weight has been regarded as one of the indices of stress conditions (Puvadolpirod and Thaxton, 2000). The reduced liver relative weights observed in the birds offered honey in the present study points to the fact that the antioxidant content in the honey used in this study was potent enough to cause change in stress resistancy. The similarity in the relative liver weights of

the birds offered vitamin C and honey is an indication that the use of honey can replace vitamin C during stress.

The gastrointestinal tract is responsive to stressors (Collins et al., 2012; Dinan and Cryan, 2012). The higher gastrointestinal relative weights of the birds that were offered honey in this study suggests that inclusion of honey in the water of the birds ameliorated the effects of heat stress on birds. This is in accordance with the findings of Mitchell and Carlisle (1992) who reported that heat stress lowered the wet and dry weight of small intestine. Moreover, Hu et al. (2010) also reported that administration of corticosterone lowered small intestinal weight and shortened small intestinal length in broiler chickens.

5 CONCLUSIONS

Addition of 20H/l of drinking water for broilers may be useful in ameliorating effects of heat stress as it improved some stress indices (serum glucose, corticosterone and creatine kinase), feed intake, body weight gain and mass of lymphoid organ (spleen). The present study has also shown that the use of honey may serve as an antioxidant for the replacement of vitamin C during stress conditions.

6 REFERENCES

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