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Physiological responses and production performance of Shika brown layers fed honey and vitamin c via drinking water

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Target Audience: *Poultry farmers, Animal Physiologist, Apiculturist and Feed industries*

Abstract

An experiment was carried out to investigate the physiological responses and production performance of Shika Brown layers fed honey and vitamin C via drinking water. A total of 120 Shika Brown laying birds was used for the study which were randomly divided into four treatment groups of 30 layers, having three replicates containing 10 layers per replicate, in a completely randomized design (CRD). The four treatments groups were served 0ml, 200mg/l of Vitamin C, 10ml honey and 20ml honey representing treatment 1,2,3,4 respectively for 84 days. Data were collected twice weekly on physiological parameters which includes heart rate and rectal temperature. Data were equally collected on production performance, haematological and serum biochemical indices. Results from the experiment showed that there were significant ($p<0.05$) differences on the heart rate and rectal temperature. Treatment groups on honey at all levels had reduced heart rate to normal range while the control group had high heart rate. Treatments 2, 3, and 4 had reduced ($p<0.05$) respiratory rate of 315bpm, 295bpm and 210bpm respectively compared to treatment 1 (355bpm). Administration of 20ml honey in the water of the birds reduced ($p<0.05$) the rectal temperature. The hen-day egg production (HDEP) was significantly influenced by the treatment where those on T_4 had increased ($p<0.05$) HDEP (80.9%) compared to other treatment groups. T_3 and T_4 haematological and serum indices were equally improved by the treatments. It is therefore concluded that inclusion of honey in drinking water especially at 20ml level of inclusion improved the physiological status and production performance of laying birds

Key words: *Physiology, Heart rate, Hen-day-egg production, Vitamin C, Honey*

Physiological status of animals refers to the overall condition of an animal body and its physiological processes at a specific point in time. It encompasses a wide range of factors that can affect an animal's health and well-being. Some of the key aspects of an animal's physiological status includes the vital signs, metabolism, stress level, reproductive status, immune system function, nutritional status and overall health and disease status. Climate can have a significant impact on the physiological status of laying birds, affecting their overall health, productivity and wellbeing. Challenge of climate and its impact on livestock production has led to decline in animal protein supply (1) Laying birds are sensitive to changes in environmental condition, particularly temperature, humidity and air quality (1). Animals of chicken species, like all homeothermic species, maintain a constant body temperature (41.1 from adaptive issues under conditions of variation in the breeding environment (2).

This has necessitated the need to mitigate the effect of continuous climate

change which negatively affect the physiological responses and production performance of layers. Stress leads to economic loss in animal production especially poultry as a result of stunted growth (3), reduced hen-day-egg production with high production cost and high mortality rate due to depressed immunity and reproductive failure (4). The supplementation of antioxidant in diet helps in boosting the immune system. Ascorbic acid as an antioxidant is known to donate a free molecule of hydrogen that detoxifies the harmful reactive oxygen species generated by the body, especially when the body's natural antioxidant is exhausted or overwhelmed (1). Consumption of antioxidant in the form of vitamin C and in the natural forms such as wheat honey and plant extracts or minerals can be the best way to provide the body with the most complete protection against free radical damages (4). Prolonged thermal stress leads to weakness, consistent reductions in egg weight and shell thickness in layers (4; 5). To minimize the effect of this, layers need supplemental antioxidants to enhance feed intake and productivity. layers raised within temperature range of 35^0C to 40^0C is prone to thermal stress which results to reduced hen day egg production and poor egg quality (6). During hot periods, birds pant to reduce heat stress. As the hen pants to reduce body heat, there is excessive loss of CO_2 gas from the blood (7). Panting which leads to loss of irons can be reduced by administration of antioxidants in the form of vitamin C and honey (8). Higher blood pH reduces the amount of ionized calcium and carbonate delivered to the uterus for egg shell formation increasing the amount of antioxidant especially organic products in the feed or drinking water could correct the problem (8). Birds with low physiological status usually experiences poor growth and reproductive rate and inability to adapt to environmental change and launching defense mechanisms (9). The physiological response causes changes in disease resistance, growth condition factor and behaviors of an organism (7). These can be summarized as stress response, immune response, neurobiological response and metabolic responses. Due to the quest for healthy living natural or organic substance are being advocated for healthier living as inorganic substances wreaks havoc especially when taken in high doses. Biological antioxidants plays a vital role in protecting cells from exercise induced oxidative stress. Honey is an organic sugary substance produced from the nectar of flowers by the worker bees. The antioxidant activity of honey can be attributed by its polyphenol and flavonoid contents (9). For example, honey inhibits the growth of micro- organisms and fungi, through bacteriostatic and bactericidal effects (10). Honey increased lymphocyte count and neutrophil phagocytosis in rats fed with honey than control group (9). Antioxidants improves the physiological state of animals like maintaining heart rate (10). Honey can be used as an organic source of antioxidant to replace Vitamin C in poultry production to ameliorate stress and improve productive performance. High consumption of inorganic drugs being used as antioxidants leads to residual effects which can be unhealthy for the body, hence this study is designed to investigate the effect of vitamin C and honey in the performance of laying birds.

Materials and Method

Experimental site and Season

This experiment was conducted at the Poultry Unit of the Teaching and Research Farm, Department of Animal Science, Ebonyi State University Abakaliki, Nigeria. The experiment was conducted during hot

dry season (November - December) which lasted for 84 days. The maximum and minimum environmental temperature during the e experiment was 41.8^0c and 36.6^0c while the relative humidity was 60% and 54% respectively.

Experimental Design and Treatment

One hundred and twenty Shika Brown layers were randomly divided into four treatment groups of 30 layers, consisting of three replicates with 10 layers per replicate, in a Randomized Complete Block Design (RCBD). The groups were served drinking water according to the treatment groups of 0ml (only water), 200mg/L (Vitamin C) and 10ml honey and 20ml honey representing treatments 1, 2, 3, and 4, respectively). A basal diet was served to the birds in all the treatments. The proximate composition of the diet was determined according to the methods of (11) and the values are crude protein, 17.15%, crude fat, 3.79%, crude fibre 3.57%, ash 7.33% and moisture 8.06%.

Data Collection

Data were collected twice weekly during the hours of 14:00 -15:00 on the heart rate and rectal temperature. Two birds per replicate were randomly and gently selected and restrained and allowed to calm to avoid stress. Stethoscope was used to check the heart rate which was placed gently at the birds' breast below the wing on the left side, the number of breaths per minute was counted. After checking the heartrate, digital clinical thermometer was gently inserted inside the rectum to check the rectal temperature. Hen day egg production was calculated daily after egg picking in the evening. Three eggs per replicated were randomly picked daily and electronic weighing balance was used to measure the egg weight. Other production parameters like final body weight, feed conversion ratio and mortality were calculated at the end of the experiment. At the end of the experiment, two birds per replicate was picked and blood samples were analysed for haematological indices and serum biochemistry to determine its effect on the immune systems.

Statistical Analysis

The data collected was subjected to one-way analysis of variance (ANOVA) according to the method of (12). Significant differences observed at 5% level of probability were separated using Duncan's New Multiple Range (12)

Results and Discussion

Physiological Response

Table 1 shows the effect of honey and vitamin C in drinking water on the heart rate, and rectal temperature of laying birds. The results showed that the heart rate differed significantly ($p<0.05$) among treatments. The heart rates of the control groups were higher ($p<0.05$) compared to normal range (250-300bpm) of poultry birds which indicates abnormality. Addition of honey and Vitamin C reduced the heart rate of laying birds. Laying birds offered 10ml and 20/ml honey had the heart rate of 295bpm and 256bpm respectively followed by the group that received Vitamin C (315bpm). This could imply that the antioxidative effects of the treatments improved the heart rate and body temperature of the birds. This report is in agreement with the report of (13) and (14) that stress increases heart rate which is relevant on the spot diagnostic parameters of the state of an animal's health, before any laboratory analysis is carried out. The report from this study is also in agreement with the report of (15) who noted that honey and Vitamin C reduced the rectal temperature of broilers under thermal stress.

Table 1: Physiological Response of Layers Fed Honey and Vitamin C

Parameter	T_1 (control)	T_2 (Vit C)	T_3 10ml honey)	T4 (20ml honey)	SEM
HR (bpm)	350.60[a]	315.00[b]	295.00[b]	256.00[c]	3.17
RT°C	42.60[a]	40.50[a]	41.40[a]	39.80[b]	0.057

[a,b:]Means on the same row with different superscript are significantly (P< 0.05) different. SEM= Standard error of means
HR =Heart Rate, RT = Rectal Temperature

Production Performance

The production performance of broilers administered vitamin C and honey in their drinking water is presented Table 2. The result shows that the treatment group on 20ml honey had significant ($p<0.05$) better effects on the hen day production. This means that the antioxidative properties of honey improved the feed efficiency and wellbeing of the birds which lead to increased egg production. This report is in agreement with the report of (16) Who observed an increase in egg production, egg weight and egg shell thickness in commercial White leghorn layer chickens exposed to an 8 week hot summer period supplemented with Vitamin C. (9) equally observed increased egg production and improved egg quality in laying birds offered 20ml of honey via drinking water. Increased body weight and egg weight indicates that there was high level of feed utilization with honey water. This report is in agreement with (17) who recorded that broiler fed with vitamin C and E gained more weight compared to the control. Mortality rate was highly affected ($p<0.05$). There was high mortality rate especially on the control group and Vitamin C groups. This was as a result of heat stress and disease infection. The reduced and non-mortality rate on honey groups could be attributed to the antioxidative properties of honey which improved the health status of the birds.

Table 2: Performance Characteristics of Layers Fed with Honey and Vitamin C

Parameter	T_1(control)	T_2 Vit (C)	T_3(10ml Ho)	T_4 (20ml Ho)	SEM
Hen Day Egg Production (%)	53.30[a]	66.60[ab]	73.30[b]	80.90[c]	6.60
Egg Weight (g)	55.00[c]	57.00[b]	60.00[a]	61.00[a]	0.30
Initial Body Weight(g)	1593[a]	1580[a]	1690[a]	1580.00[a]	89.70
Final Body Weight (g)	1953.30[b]	2016.00[b]	2056.00[b]	2183.00[a]	74.00
Daily Weight Gain (g)	4.29[c]	5.13[b]	4.35[b]	7.18[a]	0.89
Daily feed intake (g)	97.98[c]	108.70[b]	107.70[b]	115.70[a]	2.13
Daily water Intake (ml)	2.10[c]	2.63[b]	2.60[b]	2.70[a]	0.07
Mortality (%)	20.00[a]	26.60[a]	16.60[b]	0.00[c]	0.53

[a,b,c:] Means on the same row with different superscripts are significantly ($p<0.05$) different .
SEM= Standard error of means
Haematological Parameters

Results of the haematological profile of layers administered honey and Vitamin C in drinking water is presented in Table 3. The result shows that the treatment had significant (<0.05) difference on the haematological indices. The control group had low PCV which indicate that the birds were anemic. This could account to high mortality rate recorded in the performance table. The increased level of PCV to fall

within the normal range of 35% -45% in adult birds in treatments groups that had honey inclusion indicate that there was improvement in the immune system or health status of the This report is in line with the report of (19) who reported that heat stress reduced the total red blood count and PCV in laying birds and inclusion of antioxidant can reduce it. This report is in agreement with the report of (20) who reported that the number of erythrocyte and leukocytes in chicken are influenced by physiologic conditions. There were no significant ($p>0.05$) differences on leukocytes, heterophils, lymphocytes The cell morphology is affected by physiological response to change in the environment as red blood cells in broiler become longer and thinner compared to controlled environment (21). The red blood cell was significantly ($p<0.05$) low in laying birds offered ordinary water in the control group compared to other treatment groups. This implies that the birds were anemic compared to the laying birds offered 20 ml honey which had normal RBC. This report is in line with the report of (19) who reported that heat stress reduced the total red blood count in laying birds. The low MCV, MCH and MCHC indicated that the birds in the control group were anemic and had reduced hemoglobin concentration which affected the oxygen caring capacity of the blood which led to paler cells in the blood. The heterophil: lymphocyte ratio showed significant ($p<0.05$) difference, where birds offered ordinary water had higher H: L compared to birds offered Vitamin C and honey. This implies that birds on the control group were under stress condition which caused elevated H: L

Table 3: Haematological profile of layers administered Honey and Vitamin C in drinking water

Parameter	T1(control)	T2 (vit C)	T3 (10ml honey	T4 (20ml honey)	SEM
PCV (%)	25.6^{b}	35.0^{a}	36.0^{a}	39.0^{a}	0.33
RBC (g/l)	2.10^{c}	2.53^{a}	2.4^{b}	2.5^{ba}	0.08
Haemoglobin (g/l)	6.23^{c}	8.08^{b}	7.20^{b}	8.33^{a}	0.10
MCH(pg)	2.80^{b}	2.93^{b}	2.93^{b}	3.30^{a}	0.12
MCV (fl)	9.0^{c}	9.46^{ba}	10.43^{ba}	12.62^{a}	0.33
MCHC (g/l)	3.30^{b}	3.30^{b}	3.70^{a}	3.60^{a}	0.03
WBC (/l)	3.85^{a}	3.7^{a}	3.53^{b}	3.30^{b}	0.57
Heterophil (%)	30.53	30.73	30.73	30.88	0.08
Lymphocyte (%)	55.36	55.50	55.60	55.80	0.03
Basophils (%)	1.86^{a}	1.83^{ba}	1.73^{ba}	1.70^{b}	0.03
Eosinophil (%)	1.76^{b}	1.86^{ab}	1.86^{ab}	1.92^{a}	0.03
Monocyte (µl)	6.30^{a}	6.33^{a}	6.40^{a}	6.43^{a}	0.05
Heterophil:Lymphocyte	0.67^{a}	0.55^{b}	0.554^{b}	0.552^{b}	0.03

$^{a,b,c:}$ Means on the same row with different superscripts are significantly ($p<0.05$) different.
PCV – Packed Cell Volume, RBC – Red Blood Cell, MCV – Mean Corpuscular Volume MCH - Mean Corpuscular Hemoglobin, MCHC – Mean Corpuscular Hemoglobin Concentration WBC – White Blood Cell

Serum Parameters

The results of serum biochemistry of layers offered honey and Vitamin C in drinking water are represented in Table 4. The results indicated that offered honey and Vitamin C to layers significantly ($p<0.05$)

influenced the total protein. The total protein value increased (P<0.05) in birds offered ordinary water, this implies that the birds were having infection and inflammatory condition This report is in line with the report of (22) who noted that total protein increased in diseased and heat stressed broilers. There was increase in the levels of Glucose, Calcium and Cholesterol level in birds without the additives compared to birds offered Vitamin C and honey. The increased cholesterol could be attributed to liver disease. A postmortem examination carried out on the mortality birds showed hepatic friable liver. The increase in glucose concentration is directly responsive to an increase in glucocorticoids hormone (23). Overactive parathyroid glands, kidney problems and certain medication can result to increase in calcium level (23). High cholesterol results from diet high in saturated fats and lack of physical activity which was not the case in this study. Therefore, the major cause of increased cholesterol was yet to be identified as the birds were served the same feed.

Table 4: Serum Biochemistry of layers fed honey and Vitamin C

Parameter	T_1(control)	T_2 (Vit C)	T_3 (10ml honey)	T_4 (20ml honey)	SEM
Total protein (g/dl)	4.83^a	4.02^a	3.50^b	3.01^b	0.059
Albumin (g/dl)	1.94^a	1.91^a	1.30^b	1.31^b	0.019
Globulin (g/dl)	2.89^a	2.79^b	2.53^b	2.49^b	0.029
Cholesterol (g/dl)	184^a	158^b	159^b	148^c	0.577
Urea (mg/dl)	$11.^a$	8.1^b	6.57^c	7.89^d	0.050
Creatinine (m/dl)	1.06^a	0.53^b	0.57^b	0.6^b	0.088
Calcium (mmol/l	6.7^c	8.01^b	11.4^a	11.08^a	0.11
Potassium (mmol/l)	6.68	6.10	6.24	6.50	0.037
Phosphorus (mmol/l)	6.19	6.13	6.15	6.13	0.066
Glucose (mg/dl)	245^a	218^b	222^c	212^b	4.04

^{a,b,c}: Means on the same row with different superscripts are significant (p<0.05) different.

Conclusion and Application

1. It is therefore concluded that inclusion of honey at 20% level improved the production capacity and welfare of the birds.
2. The inclusion of honey, increased hen day egg production, improved egg weight and reduced mortality.
3. The treatment did not show any deleterious effect on the production performance and could be used to elicit positive physiological responses of layers especially during stress conditions.
4. Honey can be used to improve the health status the laying birds through improved blood profile.

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