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Effect of selenium on growth performance, haematological indices, carcass characteristics and sensory properties of broiler chicken

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Abstract

The vital role of selenium in various metabolic reactions and its role as a component of antioxidant enzymes has awaken research interest in livestock production. Its influence on animal fertility, production and disease prevention is subject for on-going research. Deficiency of selenium have serious negative effect on animal skeletal and cardiac muscles which will in turn reduce growth, and there is dearth of information on its effect on growth performance, haematological indices and carcass characteristics of broiler chicken, the reason for this study. An experiment was carried out to investigate the effect of selenium on growth performance, haematological indices, carcass characteristics and sensory properties of broiler birds. A total of 120, one-day-old chicks were randomly assigned to four treatments in a completely randomized design and were further divided into three replicates with 10birds per replicate. Selenium was administered orally through their drinking water in three levels such that treatment (T_1) served as control. T_2, T_3, and T_4 received 0.2mg, 0.4mg, and 0.6mg, respectively. Data were collected on growth performance, haematological indices, carcass characteristics and sensory properties. Results showed selenium significantly ($p<0.05$) improved the final body weight (FBW), carcass weight, dressed weight of the birds and feed conversion ratio (FCR). Birds onT_3 (2123.33g) had the highest FBW with the least FCR (2.45) compared to those in other treatments. There were no significant ($p>0.05$) differences on the sensory properties of the meat. Result from the study showed that selenium improved the haematological indices with increased packed cell volume and haemoglobin concentration. Results obtained from this study revealed that the inclusion of selenium especially at 0.4mg level (T_3) improved the growth performance, carcass characteristics as well as the health status of the birds without having any detrimental effect on the birds

Keywords: Selenium, carcass characteristics, growth performance and haematology

Effet du sélénium sur la performance de la croissance, les indices hématologiques, les caractéristiques de la carcasse et les propriétés sensorielles du poulet à griller

Résumé

Le rôle vital du sélénium dans diverses réactions métaboliques et son rôle en tant que composant des enzymes antioxydantes a réveillé l'intérêt de la recherche dans la production de bétail. Son influence sur la fertilité des animaux, la production et la prévention des maladies est soumise à des recherches en cours. La carence du sélénium présente un effet négatif grave sur les muscles squelettiques des animaux et cardiaques qui réduira à leur tour

la croissance et il y a de la pénurie d'informations sur ses effets sur la performance de la croissance, les indices hématologiques et les caractéristiques de la carcasse du poulet à griller, la raison de cette étude. Une expérience a été réalisée pour enquêter sur l'effet du sélénium sur la performance de la croissance, les indices hématologiques, les caractéristiques de la carcasse et les propriétés sensorielles des oiseaux de poulets à griller. Un total de poussins âgés de 120 jours ont été attribués au hasard à quatre traitements dans une conception complètement randomisée et ont été divisés davantage en trois réplicats avec 10 oiseaux par réplication. Le sélénium a été administré par voie orale à travers leur eau potable dans trois niveaux de ce type de traitement (T_1) servi de contrôle. T_2, T_3 et T_4 ont reçu 0,2 mg, 0,4 mg et 0,6 mg, respectivement. Les données ont été collectées sur la performance de la croissance, les indices hématologiques, les caractéristiques de la carcasse et les propriétés sensorielles. Les résultats montraient de manière significative sélénium ($P<0,05$) amélioré le poids corporel final (PCF), le poids de la carcasse, le poids habillé des oiseaux et le rapport de conversion d'alimentation (RCA). Les oiseaux sur T_3 (2123.33g) ont eu le plus haut PCF avec le moins de RCA (2,45) par rapport à ceux d'autres traitements. Il n'y avait pas de différences significatives ($p> 0,05$) sur les propriétés sensorielles de la viande. Le résultat de l'étude a montré que le sélénium a amélioré les indices hématologiques avec une augmentation du volume de cellules emballées et de la concentration en hémoglobine. Les résultats obtenus à partir de cette étude ont révélé que l'inclusion de sélénium en particulier à 0,4 mg de niveau (T_3) a amélioré la performance de la croissance, les caractéristiques de la carcasse ainsi que l'état de santé des oiseaux sans avoir d'effet néfaste sur les oiseaux

Mot-clé; Sélénium, caractéristiques de la carcasse, performance de croissance et hématologie

Introduction

The rise in human population with the current security challenges which impairs production of large ruminant animals' calls for urgent need to increase the production of farm animals with high but short production cycle such as broiler chicken. For effective and efficient growth, use of minerals are essentials for the body's physiological and metabolic processes.Selenium is an essential trace element that birds and other wildlife need in small amount for good health. Selenium is a trace element that has a vital role in various metabolic reactions that results in better growth rate and feed efficiency. Selenium is required as a component of antioxidant enzymes such as glutathione peroxidase which destroy free radicals produced during the metabolic activity (Rotruck*et al.* (1973). Selenium is an essential microelement in animal nutrition and exerts multiple actions related to animal fertility, production and disease prevention. Selenium has effectiveness on poultry reproduction. Rutz*et al.* (2004) found an improvement in egg production, egg weight and albumen weight in laying birds fed diets with organic selenium (Jang and Jensen, 2006). Selenium was found to affect egg production and egg quality in birds. Rutz*et al*. (2004). It also acts as an immune-stimulating substance to increase the ability of the immune system to resist disease. Therefore, selenium is important for digestive enzymes secretion and thereby improving nutrient digestibility and performance (Jensen, 1968). This mineral is required by the animal but it is not made in the animal. Deficiency of selenium in an animal can have a negative effect on the animals' skeletal and cardiac muscles which in turn will reduced growth rates. Eden's *et al*. (2000) reported that organic selenium was associated with better feathering in broilers but feed conversion ratios were not affected by selenium source. It is also

reported by Agate *et al*. (2001) that selenium improves the environment of the sperm storage tubules in the hen's oviduct, allowing sperm to live longer. The need to explore the numerous benefits of selenium necessitated the need for the use of selenium in this study.

Materials and methods

The experiment was carried out at the Poultry Unit of the Department of Animal Science, Ebonyi State University. Selenium used in this study was purchased from a reputable pharmacy.

Experimental animals and management

Sixty, one day old Ross Strain broiler chicks were purchased from a reputable farm in Ibadan and used for the study. The chicks were raised and managed under deep litter system on concrete floor, other management practices were dully carried out.

Experimental design

The experiment was conducted using 120 birds in a Completely Randomized Design (CRD). The birds were randomly allotted to four treatments and each treatment was replicated three times, with 10 birds per replicate. Data were collected on performance characteristics, haematological indices, carcass characteristics and sensory properties

Performance indices

Feed Intake (g): A weighed quantity of feed was served to the birds in the morning; the leftover was collected, weighed and recorded the next day. The feed intake (FI) was obtained by subtracting the leftover from the quantity served. The daily feed intake (DFI) was determined by dividing the total feed consumed (TFC) by the number of days the experiment lasted

Feed intake per bird = Total feed served – Leftover feed.

$$DFI = \frac{\text{Total feed intake}}{\text{Number of days of the experiment}}$$

Water Intake (mL): The quantity of water served was measured and recorded and the left over was also measured to estimate the water intake. Also, a separate drinker which the broiler did not have access to was kept to estimate the evaporation loss. Water intake was calculated by subtracting the leftover water + water lose due to evaporation from the quantity served.

WI = quantity of water served – leftover + evaporated water.

Feed Conversion Ratio (FCR)

This was obtained from the ratio of the average daily feed intake to average body weight gain.

$$FCR = \frac{\text{Average feed intake (g)}}{\text{Average weight gain (g)}}$$

Initial body weight (g): The initial body weights of the birds were measured using sensitive weighing scale.

Final body weight (g): The final body weights of the birds were measured at the end of the experiment using sensitive weighing scale.

Weight gain (g): The birds were weighed before the commencement of the experiment to obtain the initial body weight (IBW) subsequently; weighed on weekly basis to obtain their weight gain using sensitive weighing scale.

Body weight gain (BWG)**:** The body weight gain was obtained by subtracting the initial body weight (IBW) from the final weight (FW). The daily weight gain was obtained by dividing the body weight gain by the number of days of the experiment

Such that: Body Weight gain $= \frac{\text{Body weight gain (g)}}{\text{Number of days of the experiment}}$

Haematological indices

At the end of the experiment, three birds each were randomly selected from each treatment and 2mL of blood samples was collected from wing vein, using sterile needle and syringes into well labelled sterilized bottles that contained ethylene diaminetetra-acetic acid (ETDA) The collected blood sample were taken to

biochemistry laboratory to evaluate the packed cell volume (PCV), Red blood cell (RBC), white blood cell (WBC) and it's differentials , haemoglobin counts (HC), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration (MCHC) according to Dein (1984).

Carcass characteristics

At the end of the experiment, two birds were randomly selected from each of the replicates and starved of feed for 12 hours but water was provided *ad libitum*. The birds were weighed individually to obtain fasted weight. They were then slaughtered and bled by severing the jugular vein with a knife Hot water was used to scald and de-feather the birds, after which each carcass was weighed, eviscerated and cut into different parts i.e. head, neck, shank, thigh, breast, wings and back. Internal organs (gizzard, heart and liver) were separately weighed. Live weight, dressed weight, dressing percentage and weight of cut parts and internal organs were recorded. Weight of cut parts and internal organs were expressed as a percentage of the live weight

Sensory properties evaluation

At the end of the experiment, one bird per replicate was slaughtered, eviscerated and the breast meat from each replicate group were used for sensory evaluation. It was cut into uniform sizes, boiled in water without salt or any spices seasoning for 30 minutes and allowed to cool. The boiled meat was served in clean plates to 10 member taste panel selected from the University community. To eliminate carry over effects, the panellists were also served with room temperature water for mouth cleansing between samples. They were instructed to evaluate the meat using a 9-point Hedonic scale for appearance, colour, juiciness, taste, tenderness and flavour, texture and overall acceptability.

Statistical analysis

Data collected from the experiment were subjected to statistical analysis using analysis of variance (ANOVA) experiment in completely randomized design (CRD). Treatment means were separated statistically using Fishers least significant difference (F-LSD) according to Steel and Torrie (1980).

Results and discussion

Effect of levels of selenium on growth response performance of broiler chickens

Results from the experiment indicates that there were significant ($p<0.05$) differences in growth parameters evaluated.

Table 1: Effect of levels of selenium on growth performance of broiler chickens

Parameters	Levels of selenium	T1 0mg	T2 0.2mg	T3 0.4mg	T4 0.6mg	SEM
Initial body weight (g)		135.33	137.33	134.67	137.33	0.43
Final body weight (g)		2088.89^{b}	2033.33^{d}	2123.33^{a}	2053.33^{c}	10.37
Body weight gain (g)		1955.56^{b}	1896.00^{d}	1988.66^{a}	1916.00^{c}	10.78
Average body weight gain (g)		34.91^{b}	33.85^{d}	35.49^{a}	34.21^{c}	0.19
Total feed intake (g)		4533.27^{b}	4526.53^{d}	4530.07^{c}	4562.27^{a}	4.28
Average daily feed intake (g)		87.17	87.07	87.12	87.74	0.25
Average daily water intake (ml)		242.87^{c}	245.33^{b}	247.37^{a}	246.66^{ab}	0.57
Feed conversion ratio (%)		2.49^{b}	2.57^{a}	2.45^{b}	2.56^{a}	0.01

^{abcd} means on the same row with different superscript are significant ($P < 0.05$)

Results from the study indicate that improvements were recorded in most of the parameters evaluated like final body weight gain, body weight gain and feed conversion ratio. This result agrees with Zhang *et al*. (2017) who studied the effect of levels of selenium on the growth performance characteristics of broiler chickens and reported significant improvement in the growth rate of the birds due to the supplementation of levels of selenium at the growing stage of the birds. The significant improvement in the growth rate of the birds could be attributed to the effect of available nutritional components and some growth stimulating effects of the selenium which probably could result in the improvement of live body weight as well as other production traits in chickens (Kakengi*et al*., 2007). The growth promoting effect of levels of selenium has been attributed to the presence of complete amino acids, considerable amount of vitamins, and mineral content, (Makkar and Becker, 1997; Fahey, 2005).

Effect of graded levels of selenium on haematological indices of broiler chickens

Data in Table 2 showed that there were significant ($p<0.05$) difference in haematological parameters evaluated.The increased packed cell volume recorded indicates that selenium can be used to reduce anaemia in poultry. This finding is in line with the findings of Machebe*et al*.(2011) who reported significant differences ($P< 0.05$) in the packed cell volume, haemoglobin count and red blood cell, of broiler finisher orally administered levels of selenium. Ani *et al*.(2013) who reported outstandingdifferencesforPCV, Hb, RBC, WBC, of broiler birds to varying dietary levels of selenium.

Table 2: Effect of levels of selenium on haematological indices of broiler chickens

Parameters Levels of selenium	T1 0mg	T2 0.2mg	T3 0.4mg	T4 0.6mg	SEM
Packed cell volume (%)	32.06^{b}	37.0^{a}	37.23^{a}	37.40^{a}	1.21
Haemoglobin (g/dl)	11.73^{a}	9.96^{b}	11.80^{a}	10.40^{ab}	0.30
Erythrocyte (10^{-12}/ml)	2.94^{b}	2.33^{b}	3.32^{a}	3.94^{a}	0.14
Leukocyte (10^{-9}/ml)	208.66^{ab}	160.33^{b}	165.66^{a}	130.33^{ab}	14.57
MCV (%)	123.40	132.50	111.66	107.73	5.12
MCH (%)	40.13	44.13	35.46	35.70	1.65
MCHC (%)	32.56	33.40	31.80	33.16	0.56

^{abc} means on the same row with different superscript are significant ($P<0.05$)

The increased leukocyte count in the control group indicates that there was high level of infection which was low in the groups on selenium treatment. The mean values of packed cell volume and haemoglobin count recorded in this study are not within the range reported by Iheukwumene and Herbet (2003) whose values were 24.67-30. 69% and 9.0-13.0% indicated that the birds were neither dehydrated. The observed increase in haemoglobin concentration of birds on these treatments may be due to the high mineral and vitamin content of selenium. Iweala and Obidoa (2009) observed that the high mineral and vitamin content of levels of selenium stimulated the synthesis of haemoglobin leading to their increase in the blood volume.

Effect of graded levels of selenium on carcass characteristics of broiler chickens

There were significant ($p<0.05$) differences in the carcass characteristics evaluated such as live weight (g), carcass weight (g) and shank as shown in Table 3.Data from the experiment indicates that the treatment had

no effect in most of the parameters evaluated but positive effect on the birds was observed in the live, carcass weight and shank percentage. This result agreed with Ropstad (1988) who observed significant increase in final weight and dressed weight of finisher broiler chicken fed graded inorganic selenium which was attributed to its antioxidant enzymes. Researchers (Fessler *et al*., 2003; Maylan*det al*., 2006) reported high levels of antioxidant found in selenium which led to significant difference in carcass traits of broiler chickens at 46 days. The increased carcass weight in treatment groups that received selenium agrees with the findings of Ohlendorf*et al*. (1988) who observed that inclusion levels of selenium in poultry diet increased the carcass weight of broiler birds

Table 3: Effect of graded levels of selenium on carcass characteristics of broiler chickens

Parameters Levels of selenium	T1 0mg	T2 0.2mg	T3 0.4mg	T4 0.6mg	SEM
Live weight (g)	2088.89^{b}	2033.33^{d}	2123.33^{a}	2053.33^{c}	10.37
Carcass weight (g)	1720.0^{c}	1934.0^{a}	1940.00^{a}	1800.00^{b}	18.41
Shank (%)	60.00^{b}	50.00^{c}	80.00^{a}	50.00^{c}	3.69
Neck (%)	80.00	80.00	80.00	80.00	0.00
Head (%)	40.00	40.00	40.00	40.00	0. 00
Wing (%)	120.00	120.00	120.00	118.00	0.26
Drumstick (%)	120.00	160.00	140.00	120.00	5.00
Gizzard (%)	40.00	40.00	40.00	40.00	0.00
Breast (%)	400.00	410.00	400.00	380.00	3.28
Back (%)	160.00	200.00	190.00	140.00	7.19
Spleen (%)	5.00	3.00	4.00	5.00	0.25
Thigh (%)	140.00^{b}	160.00^{a}	160.00^{a}	120.00^{c}	5.00
Liver (%)	25.00	30.00	30.00	30.00	0.65
Heart (%)	100.00	100.00	100.00	100.00	0.00

^{abcd} means on the same row with different superscript are significant (P<0.05)

Table 4: Effect of graded levels of selenium on sensory properties of broiler chickens

Parameters Levels of selenium	T1 0mg	T2 0.2mg	T3 0.4mg	T4 0.6mg	SEM
Appearance	7.80	7.50	7.80	7.00	0.06
Colour	7.50	7.80	7.80	8.20	0.07
Texture	7.40	8.30	7.80	7.00	0.14
Flavour	4.20	4.00	4.30	3.90	0.04
Tenderness	3.30	3.8	3.60	3.70	0.05
Taste	3.70	3.40	3.50	3.30	0.04
Juiciness	4.60	3.80	3.60	3.50	0.13
Acceptability	2.40	2.40	2.50	2.10	0.12

SEM= Standard Error of Means.

Result from this study showed that there were no significant differences in the parameters evaluated. The result is not in agreement with the findings of Brown and Arthur (2001) who reported that levels of selenium enhanced and enriched broiler meat in terms of flavour and appearance with a notable statistical difference.

Conclusion

The study showed that selenium improved the growth performance through enhanced feed utilization and physiological status of the birds. The increased packed cell volume, erythrocyte and haemoglobin showed that selenium can be used to prevent anaemia and control infection

thereby improving the health status the birds. Based on the study, selenium at 0.4mg levels of inclusion could be considered as potential additives in poultry production.

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