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Effect of varying level of ginger powder in the diet of starter turkeys on performance, haematological and serum biochemical indices

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Abstract

Dietary inclusion of various phytogenic additives has been used as alternative growth promoters in poultry. They enhance performance and stabilize health status of farm animals. This study was conducted to investigate the effect of inclusion of ginger powder to the diets of pre starter and starter turkeys at different levels (0g/kg, 2g/kg and 4g/kg) on its performance and some blood parameters. A total of one hundred and twenty day- old British United Turkey (BUT) poults were allotted on weight equalization basis into the 3 dietary treatments in a complete randomised design. Forty poults were assigned to each treatment group replicated four times with 10 poults per replicate. The study lasted for 56 days comprising of the pre-starter (0-28 days) and starter (29-56 days) phases. At the pre-starter phase of the experiment, growth performance was not affected ($p>0.05$) by ginger powder inclusion while the starter phase showed improved ($p<0.05$) final weight, feed intake and feed conversion ratio. Final weight increased ($p<0.05$) with ginger inclusion in the diets, while feed intake reduced linearly as ginger inclusion increased. Supplementation with ginger reduced haemoglobin and RBC of the pre starter turkeys. The RBC increases linearly ($p<0.05$) as ginger supplementation increases with starter turkeys. Serum albumin improved significantly ($p<0.05$) following dietary inclusion of 2 g/kg ginger powder at the starter (3.37 g/dl) phase. In conclusion, starter turkeys fed diet containing ginger at 2 g/kg showed improved growth with improvement in hepatic enzyme activities.

Keywords: Poults, ginger, phytogenics and performance

Introduction

Several studies have been carried out to improve the efficiency of poultry productions. Antibiotic growth promoters (AGP) could have been perfect supplements to animal feed, but the possible adverse effects posed due to the reasons like alteration of natural gut microbiota and drug resistance in bacteria and humans causes a lot of health problems. This brings about careful selection and use of appropriate non-antibiotic additives such as phytogenic in poultry nutrition (Barrow *et al*., 1992). The alternative feed additives used in livestock and poultry nutrition include probiotics (Musa *et al*., 2009), prebiotics (Gibson *et al*., 2004), organic acids (Upadhaya *et al*., 2016), enzymes (Bedford and Cowieson, 2012) and phytogenics (Gong *et al*., 2014). Feed additives are added in animal feeds to improve their nutritive value, boost animal performance by increasing their growth rate, better feed conversion efficiency, greater livability and lowered mortality in poultry birds (Onu 2010). Herbs could be expected to serve as feed additives due to their suitability and preference, lower cost of production, reduced risk of toxicity, minimum health hazards and they are also environmentally friendly (Devegowda, 1996).

Ginger as natural growth promoters can serve as alternatives for common artificial growth promoters like antibiotics (Demir *et al*., 2003). Ginger is the rhizome of the

plant *Zingiber officinale*, consumed as a delicacy, medicine, or spice. It has been reported to enhance performance, feed conversion ratio, carcass meat safety and quality in animals (Stanacev *et al*., 2011; Dhama *et al*., 2014, 2015). Besides enhancing performance, it also has anti-oxidant property, the effects of which are associated with essential oils (EOs) and their components (Lee and Shibamoto, 2001; Alagawamy *et al*., 2016). Additionally, its antimicrobial, immunomodulatory, antioxidative, and growth-promoting effects in animals have been reported by various researchers (Windisch *et al*., 2008; Jacela *et al*., 2010; Abd El- Hack and Alagawany, 2015). Dietary supplementation of ginger has the potential to increase feed intake by improving the palatability of diet possibly due to enhanced flavour and odour, especially with the use of essential oils (Kroismay *et al*., 2006). The reason for increase in voluntary feed intake resulting in improved weight gain was reported to be due to the improvement in the flavour and palatability of feed by the aromatic essential oils. Al-Homidan (2005) observed reduced growth rate in starter broilers (1 to 4 weeks) when ginger was fed at the rate of 60 g/kg body weight. However, Zhang *et al.* (2009) did not ?nd any signi?cant difference in average daily weight gain of broilers by feeding ginger at the rate of 5 g/kg. Herawati (2010) found that the use of 2 % red ginger in the ration of broiler chickens produced higher body weights. Onu (2010) reported that the addition of ginger (0.25 %) to the basal diet of broiler chicks resulted in higher body weights. Therefore, the present study was carried out to determineginger powder at 0g/kg, 2g/kg and 4g/kg would have influence on performance and some blood parameters in pre starter and starter turkey

Materials and methods

Processing of test ingredient

Ginger (*Zingiber officinale*) rhizomes were sourced from a reputable farm (market). Freshly harvested ginger rhizomes were washed with clean water (to remove adhering dirt and sand), then chopped into smaller pieces, sun dried and ground to pass through sieve size 1mm screen to obtain ginger powder. The ginger powder was stored in an air tight container.

Experimental diets

Three dietary treatments were formulated according to NRC (1994) requirement for starter turkeys in which ginger powder was included at 0, 2 and 4 g/kg for treatment 1, 2 and 3, respectively. The experimental diets for the pre-starter (0-28 days) and starter (29-56 days) phases are shown in Tables 1 and 2.

Experimental design and management

A total of one hundred and twenty day- old British United Turkey (BUT) poults were allotted on weight equalization basis into the three dietary treatments in a complete randomised design. Forty poults were assigned to each treatment group replicated four times with 10 poults per replicate. The study lasted for 56 days comprising of the pre-starter (0-28 days) and starter (29-56 days) phases. The poults were reared on a deep litter floor divided into compartments as replicates. Daily routine management practices were adhered to, fresh water and feed were supplied daily *ad libitum*.

Table 1: Gross composition of experimental diets fed to pre-starter turkeys (0-28days) (g/kg)

Ingredients	T1	T2	T3
Maize	430.00	428.00	426.00
Ginger powder	0.00	2.00	4.00
Soybean meal	412.00	412.00	412.00
Fish meal (72%CP)	80.00	80.00	80.00
Bone meal	45.00	45.00	45.00
Oyster shell	20.00	20.00	20.00
Premix	5.00	5.00	5.00
Salt	2.50	2.50	2.50
Lysine	1.50	1.50	1.50
Methionine	4.00	4.00	4.00
TOTAL	1000.00	1000.00	1000.00
Determined analysis (%)			
Crude protein	28.19	28.17	28.18
Crude fibre	30.00	30.00	30.00
Ether extract	37.80	37.77	37.79
Calcium	21.60	21.60	21.60
Phosphorus	8.60	8.60	8.60
Metabolizable energy (MJ/kg)	11.93	11.88	11.87

T1 – Control diet, T2 – diet with 2 g/kg ginger powder, T3 – diet with 4 g/kg ginger powder

Table 2: Gross composition of experimental diets fed to starter turkeys (29-56 days)(g/kg)

Ingredients	T1	T2	T3
Maize	500.00	498.00	496.00
Ginger powder	0.00	2.00	4.00
Soybean meal	360.00	360.00	360.00
Fish meal (72%CP)	90.00	90.00	90.00
Palm oil	5.00	5.00	5.00
Wheat offals	5.00	5.00	5.00
Bone meal	19.00	19.00	19.00
Oyster shell	10.00	10.00	10.00
Premix	5.00	5.00	5.00
Salt	2.50	2.50	2.50
Lysine	1.50	1.50	1.50
Methionine	2.00	2.00	2.00
TOTAL	1000.00	1000.00	1000.00
Determined analysis (%)			
Crude protein	26.06	26.05	26.05
Crude fibre	29.30	29.30	29.30
Ether extract	38.20	38.20	38.20
Calcium	12.80	12.80	12.80
Phosphorus	5.30	5.30	5.30
Metabolizable energy (MJ/kg)	12.04	12.02	12.00

T1 – Control diet, T2 – diet with 2 g/kg ginger powder, T3 – diet with 4 g/kg ginger powder.

Parameters measured

Growth performance

Body weight measurement

The initial body weight of the poults per replicate was taken at day old and subsequently on weekly basis using a measuring scale. Feed intake was recorded daily. The weight gain and feed conversion

ratio (FCR) were calculated on weekly basis. Mortality was recorded as it occurred and expressed as percentage of poults stocked.

Blood collection and determination

At the end of each phase (28 and 56 days), blood samples were collected (in the morning) through wing web by vein puncture from two poults per replicate into two separate sample bottles (plain serum bottle and EDTA bottle) using a sterilized needle and syringe for serum biochemistry and haematological indices measurement. Haematological parameters measured include haemoglobin (Hb), red blood cells (RBC), packed cell volume (PCV) and white blood cells (WBC) counts were estimated in whole blood just after bleeding, using standard procedures (Jain, 1986).

The blood samples for serum profile were allowed to clot before centrifuging at 1100-1300 rpm for 15 minutes. Separated sera were decanted into bijoh bottles and stored at -20^{0}C until analyzed. Serum glucose was determined colorimetrically using GOD/PAD method. Serum uric acid was determined using enzymatic colorimetric method as described by Fossati *et al.* (1980). Total serum protein was determined using biuret method as described by Tietz (1995). Serum albumin was determined using the bromocresol purple method of Varley *et al.* (1980). Serum globulin was estimated by subtracting the results of the serum albumin from the serum total protein. The hepatic serum enzyme activities (Alanine aminotransferase (ALT), Aspartate aminotransferase (AST) and alkaline phosphatase) were estimated using appropriate commercial kits. AST and ALT assays were determined using Randox diagnostic kit (Randox, 2012).

Statistical analysis

All data obtained were subjected to one-way analysis of variance in a complete randomised design and analysed using SAS (1999) package. Orthogonal means comparison was also done to determine the linear and the quadratic trend of various inclusion levels of ginger (SPSS, 1999).

Results

The effect of varying level of ginger on growth performance of starter turkeys is shown in Table 3. The weight gain, feed intake, feed conversion ratio and mortality were not significantly ($p>0.05$) affected by varying levels of ginger in the first 28 days. The final weight, feed intake and feed conversion ratio were significantly affected ($p<0.05$) by varying levels of ginger during the last 28 days. At the end of 56 days experiment poults fed control diet had the least ($p<0.05$) final weight (3625.00g) while higher ($p<0.05$) values were observed in poults fed 2 g/kg and 4 g/kg ginger powder inclusion. The feed intake reduced linearly ($p<0.05$) as ginger supplementation increased across the treatment. The turkeys fed ginger diets had improved ($p<0.05$) feed conversion ratio as compared to turkeys fed control diet.

Table 4 shows the effect of varying levels of ginger on haematological indices of pre starter and starterturkeys. At the end of 28 days, the packed cell volume, haemoglobin, red blood cell, white blood cell, heterophil, lymphocyte and monocytes were significantly ($p< 0.05$) affected by varying levels of ginger. The poults fed control diets had the highest ($p<0.05$) PCV (42.00), Hb (13.50), RBC (3.83) and WBC (15.47) values. PCV and WBC initially reduced when 2 g/kg ginger was supplemented but increased with 4% ginger supplementation. Supplementation with ginger reduced Hb and RBC of the pre starter turkeys. Ginger supplementation at 4 g/kg recorded the highest ($p<0.05$) heterophil count while

Table 3: Effect of varying levels of ginger on growth performance of pre-starter (0-28 days) and starter (29 -56days) poults

	Ginger inclusion levels (g/kg)			Pooled SEM	P-values	
Parameters	0	2	4		Linear	Quadratic
Pre starter (0-28days)						
Initial weight (g/bird)	56.28	56.40	57.45	0.22	0.090	0.233
Final weight (g/bird)	1508.73	1461.88	1495.35	43.20	0.911	0.698
Weight gain (g/bird/day)	51.87	50.20	51.35	1.54	0.903	0.702
Feed intake (g/bird/day)	39.43	39.31	39.35	0.027	0.216	0.181
FCR	0.77	0.79	0.77	0.023	0.936	0.691
Mortality (%)	1.33	0.67	0.00	0.05	0.123	0.064
Starter (29-56days)						
Initial weight (g/bird)	1508.73	1461.88	1495.35	43.20	0.911	0.698
Final weight (g/bird)	3625.00^{b}	3965.00^{a}	3907.50^{ab}	61.78	0.037	0.078
Weight gain (g/bird/day)	75.58^{b}	89.39^{a}	86.15^{ab}	2.51	0.055	0.070
Feed intake (g/bird/day)	135.93^{a}	124.10^{b}	119.54^{c}	2.10	<0.001	<0.001
FCR	1.82^{b}	1.39^{a}	1.39^{a}	0.74	0.004	0.055
Mortality (%)	0.67	0.34	0.67	0.05	0.342	0.652

FCR: Feed Conversion Ratio, SEM: Standard Error of Mean

Table 4: Effect of varying levels of ginger on haematological indices of pre-starter (0-28 days) and starter (29 -56 days) poults

	Ginger inclusion levels (g/kg)			Pooled SEM	P-values	
Parameters	0	2	4		Linear	Quadratic
Pre-starter (0-28days)						
PCV (%)	42.00^{a}	25.00^{c}	32.00^{b}	2.64	0.010	0.002
Hb (g/dl)	13.50^{a}	9.00^{b}	10.20^{b}	0.73	0.006	0.006
RBC ($x10^{6}/mm^{3}$)	3.83^{a}	2.03^{b}	2.43^{b}	0.29	0.001	0.002
WBC ($x10^{6}/mm^{3}$)	15.47^{a}	11.93^{c}	13.00^{b}	0.64	0.055	0.043
Heterophil ($x10^{9}/l$)	29.00^{b}	31.67^{b}	39.67^{a}	1.65	0.000	0.034
Lymphocyte ($x10^{9}/l$)	65.66^{a}	70.00^{a}	58.67^{b}	1.79	0.011	0.003
Eosinophil ($x10^{9}/l$)	0.67	0.33	0.33	0.18	0.506	0.697
Basophil ($x10^{9}/l$)	1.00	0.33	1.00	0.22	1.000	0.207
Monocyte ($x10^{9}/l$)	2.67^{a}	0.33^{b}	2.00^{a}	0.37	0.134	0.001
Starter (29- 56days)						
PCV (%)	29.00^{b}	33.00^{a}	33.00^{a}	0.73	0.003	0.030
Hb (g/dl)	9.33^{b}	11.47^{a}	10.83^{a}	0.34	0.003	0.002
RBC ($x10^{6}/mm^{3}$)	2.40^{c}	2.53^{b}	2.73^{a}	0.063	0.025	0.743
WBC ($x10^{6}/mm^{3}$)	14.03^{b}	11.93^{c}	15.63^{a}	0.58	0.036	0.001
Heterophil ($x10^{9}/l$)	33.67^{a}	31.67^{b}	29.67^{c}	0.79	0.043	1.000
Lymphocyte ($x10^{9}/l$)	62.33^{b}	68.67^{a}	66.67^{a}	1.12	0.049	0.034
Eosinophil ($x10^{9}/l$)	0.67	0.67	1.00	0.15	0.420	0.635
Basophil ($x10^{9}/l$)	1.00	0.33	0.67	0.24	0.604	0.379
Monocyte ($x10^{9}/l$)	2.00	1.33	1.00	0.29	0.214	0.798

^{abc}Mean values in same row having different superscripts are significantly different (P<0.05) PCV: Packed Cell Volume, Hb: Haemoglobin, RBC : Red Blood Cell, WBC: White Blood Cell, SEM: Standard Error of Mean

ginger supplemented at 4 g/kg recorded the lowest (p<0.05) lymphocyte count. The pre starter turkeys fed diets containing 2 g/kg ginger recorded the lowest (p<0.05) monocyte count.

The effect of varying levels of ginger on haematological indices of starter turkeys is shown in Table 4. PCV, Hb, RBC, WBC, Heterophil and lymphocyte were significantly influenced (p< 0.05) by varying levels of ginger in the last phase of the study. Starter turkeys fed control diets had the lowest PCV (29.00), Hb (9.33), RBC (2.40) and lymphocyte (62.33) counts. The starter turkeys fed with 2 g/kg and 4 g/kg ginger had higher (p<0.05) values of PCV, Hb and lymphocyte than those fed control diets. The RBC increases linearly (p<0.05) as ginger supplementation increases while the heterophil count reduces linearly (p<0.05) as ginger supplementation increases. The starter turkeys fed diets containing 2 g/kg ginger recorded the lowest (p<0.05) WBC. The WBC value initially reduces (p<0.05) with 2 g/kg ginger supplementation but later increased (p<0.05) at 4 g/kg ginger supplementation.

Table 5 shows the effect of varying levels of ginger on serum chemistry of pre starter turkeys. Serum albumin, Alanine aminotransferase (ALT), Aspartate transaminase (AST) and Alkaline phosphatise (ALP) were significantly (p<0.05) affected by varying levels of ginger. Meanwhile, total serum protein, serum globulin, serum uric acid and serum creatinine were not affected (p>0.05) by varying levels of ginger. The pre starter turkeys fed control diets had the highest (p<0.05) serum albumin, AST, ALT and ALP. Serum albumin, ALP, AST and ALT reduced (p<0.05) linearly with increasing levels of ginger.

Total serum protein, serum albumin, serum uric acid, AST, ALT and ALP at the end of

Table 5: Main effect of varying levels of ginger on serumchemistry of pre-starter (0-28 days) and starter (29 -56 days) poults

	Ginger inclusion levels (g/kg)			Pooled SEM	P-values	
Parameters	0	2	4		Linear	Quadratic
Pre-starter (0-28days)						
Total serum protein (g/dl)	8.27	5.53	6.07	0.66	0.180	0.241
Serum albumin (g/dl)	4.50^{a}	3.30^{b}	2.47^{c}	0.39	0.034	0.785
Serum globulin (g/dl)	3.77	2.23	3.60	0.45	0.881	0.167
Serum uric acid (mg/dl)	5.60	3.23	4.80	0.49	0.452	0.063
Serum creatinine (mg/dl)	0.93	0.57	0.57	0.12	0.248	0.488
AST (U/l)	91.33^{a}	64.00^{b}	69.67^{b}	4.96	0.029	0.046
ALT (U/l)	48.00^{a}	31.33^{b}	29.67^{b}	3.03	<0.001	0.008
ALP (U/l)	35.33^{a}	30.67^{b}	22.33^{c}	1.96	0.0002	0.163
Starter (29-56days)						
Total serum protein (g/dl)	4.53^{a}	4.77^{a}	3.57^{b}	0.20	0.003	0.006
Serum albumin (g/dl)	2.76^{b}	3.37^{a}	2.03^{c}	0.20	0.003	<0.001
Serum globulin (g/dl)	1.77	1.40	1.53	0.08	0.162	0.096
Serum uric acid (mg/dl)	3.90^{a}	3.20^{b}	2.57^{c}	0.02	<0.001	0.798
Serum creatinine (mg/dl)	0.63	0.70	0.63	0.04	1.000	0.518
AST (U/l)	60.67^{a}	63.33^{a}	53.33^{b}	1.62	0.006	0.006
ALT (U/l)	29.00^{a}	30.33^{a}	25.67^{b}	0.88	0.043	0.038
ALP (U/l)	29.00^{a}	20.00^{c}	24.67^{b}	1.38	0.015	0.001

^{abc}Mean values in same row having different superscripts are significantly different (P<0.05) ALT: Alanine Aminotransferase, AST : Aspartate Transaminase, ALP: Alkaline Phosphatase, SEM: Standard Error of Mean

day 29 to 56 trials were significantly affected ($p< 0.05$) by varying levels of ginger. Meanwhile, serum globulin and serum creatinine were not affected ($p>0.05$) by ginger inclusion. Starter turkeys fed control diets recorded the highest ($p<0.05$) ALP and serum uric acid. Serum uric acid reduces linearly ($p<0.05$) with increasing levels of ginger. Dietary supplementation of ginger at 4 g/kg inclusion level in the present study reduced ($p<0.05$) total serum protein, AST and ALT. However, similar values of total serum protein, AST and ALT were observed for birds fed control diets and 2 g/kg supplementation. The starter turkeys fed 2 g/kg ginger supplementation had the lowest ($p<0.05$) ALP and highest ($p<0.05$) serum albumin concentration. Serum albumin increased initially with 2 g/kg ginger supplementation but later reduce with 4 g/kg supplementation of ginger while ALP reduced initially at 2 g/kg ginger supplementation but later increased with 4 g/kg supplementation.

Discussion

The non-significant effect of ginger inclusion on growth response of pre-starter turkeys could be attributed to the active growing phase of the bird. At this stage, the experimental diets offered (ME= 11.93 MJ/kg, CP= 28.19%) met the necessary requirement of the bird and hence could probably mask the effect of additional ginger included (Olukosi *et al.*, 2007). It could also be due to inadequate doses of ginger included which may not show significant effect on growth. Previous findings also confirmed non-significant effect on broilers fed diet containing ginger. El-Deek *et al*. (2002) observed that a diet containing 1 g/kg of ginger showed no effect on growth performance. In a similar study, Dieumou *et al* (2009) fed ginger essential oils to broilers and found no differences among the ginger oil diets and the control in terms of feed intake, body weight gain and feed conversion ratio.

Meanwhile, the growth performance of starter poults was influenced following ginger inclusion. Ginger inclusion increases the final bodyweight of starter poults. Onu (2010) reported that the addition of ginger (0.25 %) to the basal diet of broiler chicks resulted in higher body weights. Herawati (2010) also confirmed positive improvement in body weight of Hubbard broilers fed 2 g/kg supplemental red ginger recording higher final body weight when compared to the control group. Furthermore, Ebrahimi *et al*. (2013) also observed an improvement in the body weight gain, mortality rate and feed conversion of broilers. Arkan *et al.* (2012) reported that those fed 2 g/kg level of ginger diet improve performance and weight gain of broiler. The highest final weight in the present study obtained with turkeys fed ginger powder diets at starter phase. The improved body weight may be due to the essential oils present in ginger, causing higher feed efficiency and enhanced growth (Kamel, 2001).

Cabuk *et al.* (2006) reported that adding a mixture of medicinal plant extracts on broilers feed reduced feed intake when compared to control groups. Barazesh *et al*. (2013) reported that Ross chicks fed diets containing varying levels of ginger powder resulted in reduced feed intake but with the best feed conversion ratio when compared to control group. The reduction in the feed conversion ratio observed with turkeys fed ginger diets in this study when compared with control in starter poults may be attributed to the presence of essential oils (zingiberen, zingerol, oleoresin, borneol etc) which have appetite and digestion stimulating properties (Kamel, 2001). This observation with regards to improved feed

conversion ratio agreed with past literatures (Tollba, 2003; Herawati, 2006; Herawati, 2010). Similar phytogenic plants like turmeric have also been reported by Mehala *et al*. (2008) to show significant improvement on FCR. The observed trend in the feed conversion ratio of starter turkey was in line with the findings of Ebrahimi *et al*., (2013) who reported improvement in feed conversion ratio of broilers fed ginger diets.

Haematological parameters are good indicators of the physiological status of animal and its changes are of value in assessing the response of animals to various physiological situations (Esonu *et al*., 2006). Esonu *et al*. *(*2007) stated that haematological constituents reflect the physiological responsiveness of the animals and the influence of diet on haematological traits (Church *et al*., 1984; Babatunde *et al*., 1992). At the pre-starter phase, there was a decline in haemoglobin concentrations with inclusion of ginger when compared with control group. However, haematological indices observed in this study were within the normal range (24.90 – 45.20 %) for healthy birds as reported by Banerfee (2008). Haemoglobin and packed cell volume are very sensitive to the levels of protein intake as the values increase with increase in dietary protein concentration (Edoziem and Switzer, 1977). The reduction in PCV obtained at the pre starter phase inadequate diets could be linked with early exposure of the bird to the essential oils present in ginger causing adverse effect on the health of the birds. Ogbuewu *et al.* (2001) also observed similar reduction in haemoglobin concentration and packed cell volume of female rabbits fed with neem leaf.

At the starter phase, turkeys fed ginger supplemented diets had higher PCV and Hb values when compared with control. The increase PCV observed is an indication that the oxygen carrying capacity of the turkeys is high which suggested absence of nutritional anaemia. Moses (1999) linked anaemia with reduction in haemoglobin, accompanied by fall in red blood cell count and packed cell volume. The range of Hb values at the starter phase was in line with the normal range for healthy birds as reported by Mitruka and Rawnsley (1977). Edozien and Switzer (1977) who reported that increased Hb value implied increased dietary protein utilisation. Poor nutrient utilization in birds has been linked with reduced Hb values (Emenalom *et al*., 2004). Furthermore, an increase in the count of RBC, Hb and PCV is suggestive of positive erythropoiesis (Iranloye, 2002; Okpuzor *et al*., 2009). The decrease in WBC observed with 2 g/kg ginger supplementation shows that the birds were in good state of health. Etim *et al*., (2014) reported that an increased in WBC shows that the immune status of the birds was challenged indicative of stress. Response of birds to ginger has been reported to be dose-dependent (Zhang *et al*., 2009). This implied that 2 g/kg ginger inclusion is optimal for improved health status of the birds. Increased WBC counts at 4 g/kg ginger noticed could be attributed to physiological efforts of the turkeys in increasing their body immunity following intake of excessive dosage of some active compounds in ginger. Excessively high WBC beyond normal has been reported in cases of infection, inflammatory conditions, allergy and stress (Eggum, 1989; Soetan *et al*., 2013).

Based on this research it can be concluded that dietary inclusion of ginger resulted in improved feed conversion ratio for starter poults. Serum enzymes were reduced following ginger inclusion in pre starter turkeys while improved serum albumin was obtained in starter poults fed 2 g/kg ginger.

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