GROWTH PERFORMANCE AND CARCASS TRAITS OF BROILERS FED WITH *ALLIUM SATIVUM* POWDERS SUPPLEMENTED FINISHER DIETS

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ABSTRACT

This study investigated the effects of dietary Allium sativum powder (ASP) on growth performance, haematology, carcass quality, serum biochemistry, and lipid profile of broilers. Before use, the ASP was phytochemically analyzed. 108 four-week old broilers were randomly assigned to four treatments (A, B, C and D) with three replicates of nine birds. They were fed for four weeks with broiler finisher diet supplemented with ASP at 0.00 (A, control), 20.00 (B), 30.00 (C) and (D) 40.00 g/kg. Weekly feed intake, weight gain, feed conversion ratio, haematology, serum biochemistry and lipid profile were determined. At week four, two birds from each replicate were randomly selected, humanely sacrificed and used to determine carcass quality. Ethanolic extract of ASP contained saponins, tannins, steroids and terpenoids. ASP supplemented groups consumed significantly more (p<0.05) feed on week three, had higher final body weight and recorded lower mortality. Low density lipoprotein (LDL) was significantly lower (p<0.05) in birds fed 20 g/kg/d than other ASP fed birds. The consumption of ASP had no significant effect (p>05) on cholesterol; high density lipoprotein (HDL), very low density lipoprotein (VLDL) and organ weights of broilers. White blood cell count was significantly higher (p<0.05) in birds fed 20.00 and 40.00 g/kg ASP. Red blood cell, haemoglobin, packed cell volume, total protein and albumin contents of the broilers were increased by the additive.

Keywords: Antibiotics, Broilers, Carcass traits, Garlic, Lipid profile

INTRODUCTION

Prior to the ban of antibiotics in 2006 as feed additive by the European Union, it had been used as major growth promoters in livestock feed. According to Ogle (2013), antibiotics were mostly used at sub therapeutic doses to promote growth and improve feed efficiency in the intensive management of animals. However, consistent use of antibiotic in this regard resulted in various health issues including resistance to the drug and evidence of resistant strains that became zoonotic (Ogle, 2013). Thus the emergence of antibiotic resistance pathogenic bacteria led to international restriction on the use of antibiotics in animal feeds. Again its continuous use as growth promoter in form of feed additive increased production cost of feed. In the tropics, particularly in Nigeria where many poultry farmers have abandoned their farms due to high cost of feed, any input that will unjustly increase cost of production should be avoided. In the management of poultry, it is therefore imperative to find other alternatives that will not only be as efficacious as antibiotics but also economically affordable.

To this regard, researches have focused on the use of naturally occurring phytobiotics in replacing the chemically based feed additives (Herawati and Marjuki, 2011). Several herbal sources have been tested and shown to effectively improve growth performance of livestock. Such herbal products have effectively been used in poultry production to improve growth performance and immunity of birds. Herbs such as *Zingiber officinale* (ginger) (Herawati and Marjuki, 2011) and *Allium sativum* (garlic) (Onyimonyi *et al*., 2011) have been used in poultry production to improve their growth performance. *A. sativum* belongs to the family Alliaceae and has been reported as the most important species of the onion genus (Block, 2010). *A. sativum* can be grown all year-round, it is readily available, affordable and is universal in distribution.

Reports on the effects of *A. sativum* on the performance of the domestic chickens have been inconsistent (Block, 2010). This study was aimed at evaluating the effect of the ASP on the growth performance and carcass traits of finisher broilers reared under tropical humid environment.

MATERIALS AND METHODS

Experimental Birds: The study was carried out at the Poultry Unit of the Department of Animal Health and Production, University of Nigeria, Nsukka. A total of 108 four-week commercial broilers (Abor Acre Plus, Sayed Consult, Ibadan, Nigeria) were used. The birds were routinely vaccinated and treated prophylactically against coccidiosis using Prococ (Pantex, Holland).

Sourcing and Processing of ASP: A single batch of the *A. sativum* used in this experiment was sourced from local markets, peeled, sun-dried and grinded into fine powder. Thereafter, it was subjected to phytochemical analysis using the methods of Trease and Evans (1983).

Experimental Diet: A commercial broiler finisher diet Hybrid Broiler Finisher Feed (Hybrid Feeds Limited, Asaba, Nigeria) was used. The ASP was weighed out using an electronic weighing balance (Satoruis, Canada) and incorporated into the finisher diet (FD) at 0.0 (A, control), 20.0 (B), 30.0 (C) and 40.0 (D) g/kg of the feed and thoroughly mixed to ensure even dispersion of the additive.

Animal Care: All applicable international, national, and/or institutional guidelines for the care and use of animals were followed (MRC, 2004).

Experimental Design: The 108 broilers chickens were weighed and randomly allotted into four treatments A, B, C and D. Each treatment was replicated three times with nine birds in each replicate (pen).The groups were fed as follows: A-the FD without ASP (control); B-FD supplemented with 20.00 g/kg ASP; C-FD supplemented with 30.00 g/kg ASP and E-FD supplemented with 40.00 g/kg ASP. The birds in each group were offered their group specific diet without antibiotics. Diets and clean drinking water were supplied *ad libitum* throughout the study period of four weeks. The stocking density was approximately 3 birds /m^2

Determination of Performance: The average body weight (ABW), weight gain (WG), feed intake (FI) and feed conversion ratio (FCR) were recorded weekly and used to assess the growth performance of the broilers (Kiczorowska *et al*., 2016). The health status of the birds was recorded daily by visually observing possible clinical signs, morbidities and mortalities.

The weekly ABW of the broilers and FI were determined by subtracting respective bird initial weights (kg) or feed intake (W_1) from the final bird weights or feed intake (W_2) and divided by number of weeks (n) ($W_2 - W_1/n$). Their FCR was determined on as-fed basis by dividing the feed consumed in a week in kg by live weight gained (kg) within the same period. Daily weight gain, feed intake and FCR were determined by dividing their respective weekly figures by seven.

Determination of Haematology and Serum Biochemistry: The packed cell volume (PCV) of the birds was determined by microhaematocrit method (Thrall and Weiser,

2002), using a haematosporin 1400, microhaematocrit centrifuge and a Hawksley Microhaematocrit Reader (Hawksley and Sons Limited, West Sussex, United Kingdom). Haemoglobin concentration was determined by the cynomethemoglobin method (Higgins *et al*., 2007) using CHEM5V3 semi-automated blood analyzer (Erba Diagnostics, Mannheim, Germany). Their RBC and WBC counts were enumerated manually following the haemocytometer method, using Natt-Herrick's solution as the diluting fluid (Natt and Herrick, 1952), improved Neubauer counting chamber (Hawksley and Sons Limited, West Sussex, United Kingdom) and a light microscope (Leica Gallen, New York, USA).

Biochemical Techniques: Total serum protein was determined in each sample following the Biuret method (Weichselbaum, 1946) using the Randox Total Protein Test kits (Randox Laboratories, Leeds, UK). Serum albumin concentration was determined following the bromocresol green method (Doumas *et al*., 1971) using the Randox Albumin Test Kit (Randox Laboratories, Leeds, UK). The serum globulin fraction was calculated by subtracting the value of the albumin fraction from the total serum protein (Busher, 1990).

The lipid profile of the experimental birds including total cholesterol, triglyceride, high density lipoprotein (HDLP), low density lipoprotein (LDLP) and very low density lipoprotein (VLDL) were determined. The serum total cholesterol was assay based on enzymatic colorimetric method (Allain *et al*., 1974). The serum triglyceride concentration was determined based on the glycerol-phosphate oxidase method (Bucolo and David, 1973). The serum high density lipoprotein concentration was determined by the dextran sulphate magnesium (II) precipitation method (Albers *et al*., 1978). The serum low density lipoprotein was calculated using Friedewald's formula (Friedewald *et al.,* 1972; Warnick *et al*., 1990). Very low density lipoprotein of the broilers was determined by dividing the value of triglyceride concentration by 5 (Bucolo and David, 1973). All assay were done using test kits manufactured by Biosystem, S. A. Costa Brava, Barcelona, Spain.

Evaluation of Carcass Quality: The dressing percentage and relative organ weight and lipid profile were used to estimate the carcass quality. At week eight, six birds from each group (two per replicate) were randomly selected, weighed and humanely sacrificed by cervical dislocation. Their gastrointestinal tracts were excised; spleen, thymus, bursa of fabricius, caeca tonsils (immune organs), liver and gizzard, were removed and their relative weights determined. Dressing percentage was determined by dividing the weight of the dressed carcass (kg) by the life weight (kg) and then multiplying by 100.

Data Analysis: Data generated were analyzed by one way analysis of variance (ANOVA) in a completely randomized design (CRD) using SPSS Data Editor Version 17. Each pen was considered as the experimental unit and treatment, the experimental model. Significance differences in the means were separated by Duncan's multiple range tests (Duncan, 1955) and significance was accepted at $p<0.05$.

RESULTS

Phytochemical Content of ASP: Phytochemical analysis showed that ethanolic extract of the *A. sativum* contained saponins, tannins, steroids and terpenoids (Table 1).

Growth Performance: Although the birds generally were in healthy condition throughout the experimental period, a mortality rate of 5.55 % was recorded: four from group A and one each from groups C and D, respectively (Table 2). Within the same period, weight gain of the ASP treated groups was improved. Although the final weights did not show any significant difference ($p>0.05$), those that consumed the supplemented diet recorded higher values (Table 2). The groups that fed the additives showed more tendency to consume more feed and on the third week feed intake among these groups was significantly higher ($p<0.05$) than the control. The FCR of birds in group B was significantly lower ($p<0.05$) than the control on weeks three and four (Table 2).

Table 1: Phytochemical analysis of *Allium sativum* powder supplemented to the broiler finisher diets

Phytochemical constituents	Tests	Positive/Negative
Tannins	Lead subacetate	Positive
	Sulphuric acid	Positive
	Ferric chloride	Positive
Alkaloids	Wagner's reagent	Negative
	Meyer's reagent	Negative
	Draggendorf"s	Negative
Saponins	Frothing test	Positive
	Emulsifying test	Positive
Flavonoids	Sodium hydroxide	Negative
Steroids	Sulphuric acid	Positive
Terpenoids	Chloroform + sulphuric acid	Positive

Table 2: Feed intake, feed conversion ratio, weekly weight gain and percentage mortality of broilers fed *Allium sativum* powder supplemented finisher diets

Parameters	Group A (0.00 g/kg)	Group B (2.00 g/kg)	Group C (3.00 g/kg)	Group D (4.00 g/kg)
Feed intake (kg)				
Week 1	1.24 ± 0.16^{a}	1.29 ± 0.14^{a}	1.46 ± 0.16^{a}	1.44 ± 0.16^{a}
Week 2	1.44 ± 0.08^{a}	1.65 ± 0.78^{a}	1.61 ± 0.08^{a}	1.41 ± 0.07^{a}
Week 3	1.51 ± 0.04^{b}	1.80 ± 0.05^{a}	1.73 ± 0.05^{a}	1.61 ± 0.06^{a}
Week 4	1.30 ± 0.06^{a}	2.01 ± 0.11^{b}	1.69 ± 0.11^{b}	1.49 ± 0.07^{ab}
Feed conversion ratio				
Week 1	3.10 ± 0.64^{b}	4.30 ± 0.23^{a}	3.56 ± 0.21^{ab}	4.14 ± 0.11^{a}
Week 2	4.11 ± 0.51^{a}	4.43 ± 0.23^{a}	3.75 ± 0.15^{a}	4.55 ± 0.23^{a}
Week 3	4.38 ± 0.42^{a}	2.90 ± 0.23^{b}	3.15 ± 0.23^{ab}	3.22 ± 0.23^{b}
Week 4	3.15 ± 0.13^{a}	2.48 ± 0.64^{b}	3.84 ± 0.83^{a}	4.81 ± 0.43^{a}
Weight gain (kg)				
Week 1	0.40 ± 0.02^{b}	0.38 ± 0.02^{b}	0.41 ± 0.02^{b}	0.38 ± 0.01^{a}
Week 2	0.35 ± 0.02^{a}	0.39 ± 0.04^{a}	0.38 ± 0.02^{a}	0.35 ± 0.03^{a}
Week 3	0.39 ± 0.01^{b}	0.62 ± 0.00^{a}	0.55 ± 0.05^{a}	0.50 ± 0.01^{a}
Week 4	0.52 ± 0.02^{b}	0.61 ± 0.01^{a}	0.54 ± 0.01^{b}	0.53 ± 0.02^{b}
Mortality (%)	4.00(0.04)	0.00(0.00)	1.00(0.01)	1.00(0.01)
Initial weight (kg)	0.79 ± 0.03^{a}	0.75 ± 0.06^{a}	0.75 ± 0.04^{a}	0.81 ± 0.03^{a}
Final weight (kg)	2.40 ± 0.08^{a}	2.63 ± 0.05^{a}	2.53 ± 0.10^{a}	2.51 ± 0.08^{a}

^{ab}Different superscripts in a row indicate significant difference at the level of probability: p<0.05

Haematology and Serum Biochemistry: Data on the haematological profile of the broilers as presented in Table 3 shows that total WBC count that was significantly higher (p<0.05) in birds from groups B and D than the control,. All other haematological indices investigated did not show any significant treatment (p>0.05) effect across the groups. Red blood cell count, haemoglobin concentration and packed cell volume were increased in the supplemented groups.

Values for total protein, albumin and globulin fraction did not show any significant variation (p>0.05) in the four groups (Table 3). Cholesterol, triglyceride and low density lipoprotein (LDL) were lower among the birds that were fed with *A. sativum* diet. High density lipoprotein (HDL) was significantly lower (p<0.05) in group D (Table 4).

Carcass Quality: Dressing percentage, relative organ weights of the lymphoid organs, liver and gizzard did not show any significant (p>0.05) difference among the groups (Table 4).

Table 3: Haematology and serum biochemistry of broilers fed *Allium sativum* powder diets

Parameters	Group A (0.00 g/kg)	Group B (2.00 g/kg)	Group C (3.00 g/kg)	Group D (4.00 g/kg)
PCV (%)	28.00 ± 1.35[a]	30.25 ± 1.11[a]	29.50 ± 1.32[a]	31.75 ± 0.63[a]
Hb (g/dL)	9.10 ± 0.58[a]	9.60 ± 0.47[a]	9.78 ± 0.73[a]	9.48 ± 0.41[a]
RBC (x10^6/µl)	4.10 ± 0.24[a]	5.59 ± 0.16[a]	5.68 ± 0.22[a]	4.77 ± 0.15[a]
WBC (x10^4/µl)	12.73 ± 0.99[b]	15.70 ± 1.08[a]	14.90 ± 1.61[ab]	13.93 ± 0.10[a]
NTRFL (x10^4/µl)	4.39 ± 0.27[a]	3.19 ± 0.42[a]	3.98 ± 0.72[a]	3.54 ± 0.32[a]
LMPCY (x10^4/µl)	13.32 ± 1.21[a]	10.51 ± 0.67[a]	10.92 ± 1.25[a]	10.38 ± 0.42[a]
TP (g/dL)	3.04 ± 0.36[a]	3.83 ± 0.10[a]	3.80 ± 0.18[a]	3.90 ± 0.14[a]
Albumin (g/dL)	1.55 ± 0.06[a]	1.95 ± 0.05[a]	2.03 ± 0.25[a]	1.78 ± 0.17[a]
Globulin (g/dL)	2.13 ± 0.34[a]	1.88 ± 0.12[a]	1.78 ± 0.22[a]	2.13 ± 0.14[a]

[ab]Different super scripts in a row indicates significant difference at the level of probability: p<0.05. Legend: PCV- Packed Cell Volume (%), Hb – Haemoglobin concentration (g/dl)RBC – Red Blood Cell (x10^6/µl), WBC- White Blood Cells (x10^4/µl), NTRFL – Neutrophil (x10^4/µl), LMPCY – Lymphocyte (10^4/µl), and TP - Total protein

Table 4: Lipid profile and carcass quality of broilers fed *Allium sativum* supplemented finisher diets

Parameters	Group A (0.00 g/kg)	Group B (2.00 g/kg)	Group C (3.00 g/kg)	Group D (4.00 g/kg)
Lipid profile (mg/dL)				
Cholesterol	151.25 ± 11.55[a]	137.00 ± 6.56[a]	130.00 ± 6.91[a]	125.00 ± 6.36[a]
Triglyceride	89.50 ± 7.08[a]	84.50 ± 11.40[a]	110.50 ± 9.36[a]	84.25 ± 8.30[a]
Low density lipoprotein	43.25 ± 3.47[a]	29.75 ± 4.61[b]	38.25 ± 6.84[a]	32.75 ± 9.20[a]
High density lipoprotein	98.00 ± 13.95[a]	107.25 ± 6.49[a]	91.75 ± 10.41[a]	62.25 ± 10.38[b]
Very low density lipoprotein	18.00 ± 1.47[a]	16.75 ± 2.17[a]	12.00 ± 1.73[a]	16.75 ± 1.55[a]
Carcass quality				
Dressing percentage	65.56 ± 0.87[a]	65.14 ± 1.07[a]	73.78 ± 5.06[a]	67.24 ± 1.35[a]
Caecal tonsil	0.08 ± 0.02[a]	0.06 ± 0.00[a]	0.06 ± 0.00[a]	0.07 ± 0.00[a]
Bursa of fabricious	0.11 ± 0.03[a]	0.12 ± 0.02[a]	0.16 ± 0.00[a]	0.13 ± 0.03[a]
Thymus	0.35 ± 0.03[a]	0.29 ± 0.03[a]	0.22 ± 0.02 [a]	0.30 ± 0.05[a]
Spleen	0.14 ± 0.01[a]	0.16 ± 0.01[a]	0.16 ± 0.03[a]	0.17 ± 0.03[a]
Gizzard	3.24 ± 0.30[a]	3.21 ± 0.06[a]	3.33 ± 0.09[a]	3.76 ± 0.37[a]
Liver	2.65 ± 0.25[a]	2.30 ± 0.22[a]	2.43 ± 0.54[a]	2.64 ± 0.15[a]

[ab]Different super scripts in a row indicates significant difference at the level of probability: p<0.05

DISCUSSION

Phytochemical analysis showed that ethanolic extract of the *A. sativum* contained saponins, tannins, steroids and terpenoids. Although the birds were generally in a healthy condition throughout the experimental period, lower mortality rates (0.00, 0.01, 0.01 and 0.04 %) were recorded among the dietary treated groups. The recorded lower mortality rate could be due to antimicrobial activities of active ingredients present in *A. sativum* which several bacterial isolates are susceptible to (Lawson, 1998). Weekly weight gain and final life body weight of supplemented groups was enhanced compared to the control group. This was in line with the observations of Issa and Omar (2012) that showed the beneficial health effects of *A. sativum* on the performance of chickens.

However, contrary to the findings of this study, Mohebbifar and Torki (2011) reported that the inclusion of mixture of thyme and garlic powder in broiler feed did not change body weight gain and gain feed ratio (GFR). The inclusion of thyme in their diet may have resulted in this variation. Also, Al-Homidan (2005) reported reduced growth rate of broilers fed starter feed containing garlic and ginger mixture at the rate of 20 and 60 g/kg. Variations in these and our result could be due to differences in age of the broilers and or use of synthetic garlic "G-PRO" in place of the

natural form of *A. sativum* that was used and the inclusion of ginger in the experimental diets.

Although we did not investigate the mechanism of action of the ASP we used, antibacterial, antioxidant, anti-stress, gut microflora manipulation, immune enhancement and digestive enzymes stimulation have been reported as the major mechanisms behind the positive effects exerted by phytogenic growth promoters on the growth and health performance of animals (Mansoub, 2011). From our results, it is therefore possible that the addition of ASP to the diets improved their growth performance and nutrient utilization efficiency through beneficial modification of gut environment of the broilers.

There was no significant difference ($p>0.05$) in the cholesterol levels among various groups fed ASP supplemented diet, when compared to the control group. However, the cholesterol level of group A was higher than other groups. This change could be attributed to the inclusion of *A. sativum* in their diet. Ahsan *et al.* (1999) had earlier reported that feeding garlic at the rate of 20 g/kg feed significantly decreased blood cholesterol in broiler chicks.

There was no significant difference ($p>0.05$) between triglyceride levels of the control and other groups. However, those fed ASP supplemented diets generally had lower values. This contradicted the report of Issa and Omar (2012) that total cholesterol, triglyceride, LDL and very low density lipoprotein (VLDL) were significantly decreased in broilers fed *A. sativum* supplemented diets. Chemical composition of the soil can affect phytochemical contents of plants. It is therefore possible that differences in environmental conditions and variations in cultivars may have resulted in inconsistency of studies on the effects of *A. sativum* on the performance of broiler chickens.

There was no significant difference ($p>0.05$) in the mean of LDL of the treated groups and the control, but birds in group B had significantly lower LDL when compared to the other three groups. The LDL was noted to be highest in birds that were fed diet supplemented with 20 g/kg diet. This finding was consistent with that of Lewis *et al.* (2003) who reported no significant difference ($p>0.05$) in the mean of LDL of broiler chickens fed *A. sativum* supplemented diet at 0.2, 0.3 and 0.4 % respectively. There was also no significant difference ($p>0.05$) between the mean of VLDL of all the groups. In contrast to our finding, Khan *et al*. (2012) reported that total cholesterol, triglyceride, LDL and VLDL were significantly decreased in chickens that were fed *A. sativum* diets.

According to Bragagnolo (2009), LDL is regarded as bad cholesterol that triggers the development of atherosclerosis in man. In the present study, the four experimental groups had LDL range value of 29.75 to 43.25 mg/dL. This figure is below the range of 130 to 159 mg/dL that is positively correlated with the formation of atherosclerosis in man (Bragagnolo, 2009). This may be an indication that supplementation of broiler finisher diet with ASP is safe for human consumers in terms of risk of development of atherosclerosis arising from their LDL contents.

The mean dressing percentage of all the four groups showed no significant difference ($p>0.05$), although birds fed 30 g/kg had higher numerical values. This was in line with the report of Lewis *et al.* (2003) that basal feed containing 0.5 % garlic powder improved feed conversion ratio and body weight gain, but failed to produce positive effect on carcass yield in terms of dressing percentage, relative organ weight of heart, gizzard, liver, spleen, pancreas, bursa and thymus of broiler chickens.

Reports on the effects of *A. sativum* on lipid profile of chickens are widely varied among researchers. Khan *et al.* (2012) reported that these variations could be due to the use of different commercial garlic products. According to Khan *et al.* (2012), *A. sativum* commercial products are divided into allicinrich and non-allicinrich products; each of this differs in the active substance it contains.

The result of this study showed that values of RBC recorded is within normal range for chickens but when compared to figures reported by previous researchers (Mitruka and Rawnsley, 1977), is high (4.10 - 5.68 x vs. 2.5 – 3.2 x 10^6 µl). This implied that this level of ASP supplementation to broiler finisher diet could be tolerated without compromising their

haemopoetic activities. Onyimonyi *et at*. (2012) reported the non-significant effects (p>0.05) of 0.25, 0.50 and 0.75 % garlic powder supplementation on haematology and serum chemistry of chickens. Also similar to our finding, Elagib and Ahmed (2011) had earlier reported non-significant effect of 3 and 5% garlic powder inclusion on the PCV, RBC, TWBC neutrophil, eosinophil, monocytes and lymphocytes. Although other haematological parameters investigated in this study were not significantly affected (p>0.05) by the dietary treatment, RBC, Hb and WBC counts were numerically higher among the supplemented groups. This may be due to the presence of some haemolytic bioactive constituents and/or their metabolites in garlic. Furthermore, other serum biochemical indices were also not significantly affected by *A. sativum* supplementation. Notwithstanding, the ASP treatment groups had higher mean protein and albumen values. Since the birds were of the same age and were managed similarly, this could suggest a more efficient protein intake and or absorption or an earlier maturation of the digestive tract (Abonyi, 2018) of the ASP supplemented groups.

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