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Full Length Research Paper

Growth and hypocholesterolemic properties of dry garlic powder (*Allium sativum)* on broilers

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A total of 160 day-old Anak broilers were used in an eight-week trial to evaluate the growth and hypocholesterolemic properties of garlic (*Allium sativum*) when fed at varying dietary levels to broilers. The 160 birds were assigned to four dietary treatments containing 0, 0.25, 0.50 and 0.75 percent garlic in treatments 1, 2, 3 and 4, respectively. Each treatment had forty birds which were replicated four times with 60 birds per replicate in a completely randomized design. The birds were fed a 24% broiler starter diet for the first four weeks of the trial and 21% finisher diets within the 5th to 8th week. Daily feed intake and weekly body measurements data were kept. Feed conversion and feed cost/kg gain values were calculated. Haematological and blood chemistry values were also determined at the end of the trial. Results show that the effect of feeding varying dietary levels of garlic on average final body weight, average daily gain and feed cost/kg gain were significant (P<0.05). There was a marked significant improvement of these parameters as levels of garlic in the treatments increased. Birds on the 0.75% garlic (Treatment 4) had significantly higher values of average final body weight, average daily gain and feed cost/kg gain. Blood haematological values obtained fell within normal ranges for domestic chicken. Increasing the level of garlic in the treatments had no significant effect (P>0.05) on the haematological and serum chemistry integrity of the birds. Cholesterol levels of the experimental birds dropped significantly (P<0.05) with increasing levels of garlic in the diets. Birds on 0.75% garlic (Treatment 4) had 76.30 mg/dl of cholesterol which differed significantly from values of 115.57, 114.29 and 103.70 mg/dl observed for birds on Treatments 1, 2 and 3, respectively. It is concluded that incorporation of sun dried garlic powder in the diets of broilers results in better performance, reduced serum cholesterol and further maintains haematological and serum chemistry integrity of the birds.

Key words: Garlic, hypocholesterolemic, broilers.

INTRODUCTION

It is well established that average per capita animal protein consumption in Nigeria falls below the recommended standard, whether National or International (Atsu, 2002). Animal protein consumption is at its peak mostly during festive periods (religious, social or cultural). Outside these periods, animal protein in the average Nigerian meal is in a tablet form or near microscopic, that is, if at all it is present. To further worsen the situation, in the recent past there is this growing concern or fright about the cholesterol content of meat.

This fright has become so popular even among the uninformed protein hungry citizens are seen to shun meat even at very rare opportunities. It is an irrefutable fact that cholesterol at certain risk levels predisposes man, especially the present day sedentary professional, to coronary heart diseases, high blood pressure, stroke and obesity (Murray et al., 2003). Cholesterol is an extremely important biological molecule that has roles in membrane structure as well as being a precursor for the synthesis of steroid hormones and bile acids (Ologhobo et al., 2008). Cholesterol in an animal tissue originates mainly from biosynthesis and to a lesser extent from dietary

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cholesterol absorbed from the intestine (Banerjee, 2009). The synthesis and utilization of cholesterol must be tightlyregulated in order to prevent over accumulation and abnormal deposition within an animal tissue. This task of reducing over accumulation of cholesterol in animal tissues has aggravated Animal Nutritionist in Nigeria to search for feed additives that have this potency.

There are evidence that garlic (*Allium sativum*) has cholesterol lowering effect in humans and animals due to the presence of sulphur-containing bioactive compounds in its homogenates (Chowdury et al., 2002; Niel et al., 1996; Shoetan et al., 1984). Garlic clove has well over 33 sulphur compounds, several enzymes, 17 amino acids and minerals especially selenium (Jennifer, 2002). These phytochemicals which are responsible for garlic sharp flavor are produced when the plant cells are damaged either by chopping, chewing or crushing. As a result of these activities, enzymes stored in cell vacuoles trigger the breakdown of several sulphur containing compounds stored in the cell fluids. The resultant compounds are responsible for the sharp or hot taste and strong smell of garlic. Allicin (diacyl disulphonate or diallyl sulphides) which is one of the most biological active compounds in garlic does not exist until it is crushed or cut. Injury to garlic bulbs activates the enzymes allinase which metabolizes allin to allicin (Koch and Lawson, 1996). Garlic appears to enhance the synthesis of nitric oxide, which accounts for its antihypertensive and coagulant effects (Masoud, 2006). Also, selenium in garlic accounts for its antioxidant and cancer preventive effects (Ross, 1999). In rabbits fed high cholesterol diet, garlic or allicin supplement significantly inhibited hypercholesterolemia, reduced tissue cholesterol, lowered low density lipoprotein concentration (LDL or bad cholesterol), raised high density lipoprotein concentration (HDL or good cholesterol) and reduced erythematous changes in aorta by 50% (Mirhadi et al., 1992; Bordia et al., 1975). Clinical studies in humans have revealed the hypocholesterolemic effect of garlic (Silagy and Neil, 1994; Warshafsky et al., 1993).

Qureshi et al. (1983) reported that garlic reduced serum cholesterol in broilers by 18%. Egg yolk cholesterol was reduced drastically by feeding 1 or 3% of garlic powder to laying hens for 3 weeks (Sharma et al., 1979). Depressed hepatic cholesterol concentration in chicken was observed when 2% garlic was fed for 14 days (Sklan et al., 1992). Masoud (2006) further reported that garlic powder when used as feed additive can activate the digestive process and this serves as an antibacterial alternative growth promoter. Inclusion of garlic to high fat diets enhanced triglyceride catabolism. Cullen et al. (2005) reported that 1% garlic supplement in pigs increased growth, feed conversion and meat quality.

Therefore, to dispel this growing concern for cholesterol in the average Nigerian, this study was designed with the objective of investigating the growth, serum cholesterol and haematological parameters of broilers fed varying dietary levels of garlic.

MATERIALS AND METHODS

Location and duration

The study was conducted at the Poultry Research Unit of the Department of Animal Science Farm, University of Nigeria, Nsukka. Nsukka lies in the derived savannah region and is on longitudes 6°25`N and latitude 7°23`E (Ofomata, 1975) at an attitude of 430 m above sea level (Breinholt et al., 1981). The study lasted for 56 days.

Preparation of garlic powder

Garlic bulbs were purchased from the Ogige Market, Nsukka. The bulbs were chopped into tiny cuts, sundried, winnowed to remove the husk and then ground into fine powder.

Management of experimental birds

A total of 180 day-old broilers of the Anak strain were purchased from a reputable distributor in Nsukka town. The birds were brooded together for the first two weeks of life in a deep litter pen measuring 3ft × 3ft. All the necessary routine vaccination and medication necessary for the birds for its entire growth cycle were strictly administered.

Experimental design

At the end of the two weeks brooding period, 160 birds were randomly selected on the basis of vigour and randomly assigned to four treatments in which garlic was incorporated at the levels of 0, 0.25 and 0.75% in treatments 1, 2, 3 and 4, respectively. Each treatment had forty birds and was further replicated into four with 10 birds per replicate in a completely randomized design.

Experimental diets

Two rations, broiler starter and finisher were formulated. Broiler starter rations were fed for the first four weeks and the finisher ration, from the 5^{th} to 8^{th} week (Tables 1 and 2).

Parameters measured

Weekly feed intake and body weight gain were recorded. Feed conversion ratio and feed cost/kg gain were also calculated for the 8 weeks experimental period.

Haematology

Blood samples for haematological examination were collected from the jugular vein of the birds. A 5-ml syringe fitted with a sterile needle was carefully inserted into the vein after manual ligation and about 2 ml of blood was withdrawn and quickly added to sample bottles containing ethylenediaminetetraacetic acid (EDTA). The sample bottle was shaken gently to mix up the blood with the EDTA to prevent dotting. The following haematological indices were determined: Haemoglobin (g/dl); packed cell volume (%); red blood cell ($\times 10^3/mm^3$); white blood cell ($\times 10^3/mm^3$); lymphocytes (%);neutrophylls (%).

Blood chemistry

Two milliliter of blood was collected also from the jugular vein and

Table 1. Percentage composition of the broiler starter ration.

Ingredient	Dietary treatment			
	1	2	3	4
Maize	7.00	7.00	7.00	7.00
Cassava chips	33.00	33.00	33.00	33.00
Groundnut cake	40.00	39.75	39.50	39.25
Palm kernel cake	10.00	10.00	10.00	10.00
Fish meal	6.00	6.00	6.00	6.00
Bone meal	3.00	3.00	3.00	3.00
Vitamin/mineral premix[a]	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25
Garlic	-	0.25	0.50	0.75
Total	100	100	100	100
Calculated				
Crude Protein	23.85	23.75	23.64	23.52
Crude Fibre	5.59	5.57	5.55	5.53
Energy (Kcal/ME/Kg)	3126	3118	3112	3110

[a]Supplied per kg of diet: 5000 IU Vitamin A; 1,000,000 IU vit. D_6; 800 mg vit. E; 400 mg vit. K, 1,200 mg vit B_2; 1,000 mg vit. B_3; 4 mg vit. B_{12}; 3,000 mg niacin; 4,000 mg vit. C; 112,000 mg chlorine; 24000 mg Mn; 8,000 mg Fe; 1600 mg Cu; 18,000 mg Zn; 500 mg iodine, 48 mg selenium; antioxidant (BHT).

put in sample bottles without anti-coagulant. The blood was allowed to clot for 30 min, after which it was centrifuged at 3000 revolutions per minutes for 10 min in order to separate the serum from the clot. After the centrifugation, the serum was carefully collected and transferred into a clean sample bottle and the blood chemistry tests were performed thereafter. The following blood chemistry indices were determined: Blood urea (mg/dl); serum creatinine (mg/dl); aspartate amino transferase (AST) (U/L); alanine amino transferase (ALT) (U/L); alkaline phosphatase (U/L); serum bilirubin.

Cholesterol determination

Cholesterol in serum was determined using the methods of Abell et al. (1952).

Analysis of data

All data collected were subjected to analysis of variance in a completely randomized design using the SAS (2000) computer package. Significantly different means were separated using Duncan's multiple range test in the same package.

RESULTS AND DISCUSSION

The results of the performance of the broilers used in this study are presented in Table 3. Results show that the effect of feeding dried garlic powder on average final body weight (AFBW), average daily gain, and feed cost/kg gain of the birds were significant. Birds on 0.75% garlic powder (Treatment 4) had significantly ($P<0.05$) higher AFBW of 2780 g, which differed significantly from the 2240, 2350 and 2460 g recorded for birds in the control and treatments 2 and 3 diets, respectively. Average daily gain (g/b/d) followed the same trend as AFBW. The same birds on the 0.75% garlic powder diet (Treatment 4) had significantly ($P <0.05$) higher values of ADG (g/b/d) of 48.62, which differed significantly from the values of 38.98, 40.95, and 42.90 recorded for birds on Treatments 1, 2 and 3, respectively. Feed cost/kg gain of the birds on Treatment 4 were significantly ($P <0.05$) different from those of Treatments 1, 2 and 3 respectively. There is evidence in the literature that garlic significantly enhanced villus and globlet cell numbers in the duodenum, jejunum and ileum of birds. As a result of these intestinal morphological changes, the entire absorptive process in the birds is better activated. In this way nutrient absorption is enhanced with the resultant growth promoting effect (Tatara et al., 2005; Masoud, 2006). Garlic has also been considered as an attractive alternative to antibiotics owing to its antimicrobial properties which further enhances the immune responses of the animal. These attributes of garlic may have yielded the superior average final body weight and average daily gain values observed in the present study. This is in tandem with earlier reports of Qureshi et al. (1983) and Sklan et al. (1992). The significantly low feed cost/kg gain obtained for birds on the 0.75% dried garlic powder diet is of huge practical benefit. The primary concern of every

Table 2. Percentage composition of the broiler finisher ration.

Ingredient	Dietary treatment			
	1	2	3	4
Maize	7.00	7.00	7.00	7.00
Cassava chips	38.00	38.00	38.00	38.00
Groundnut cake	27.00	26.75	26.50	26.25
Palm kernel cake	19.00	19.00	19.00	19.00
Fish meal	5.00	5.00	5.00	5.00
Bone meal	3.00	3.00	3.00	3.00
Vitamin/mineral premix[a]	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25
Garlic	-	0.25	0.50	0.75
Total	100	100	100	100
Calculated				
Crude Protein	20.36	19.93	19.82	19.70
Crude Fibre	5.77	5.75	5.73	5.71
Energy (Kcal/ME/Kg)	2840	2834	2827	2822

[a]Vitamin premix (2.5 kg/1000 kg); vitamin A (15,000,00 IU), vitamin D_2 (3,000,000 IU); vitamin E (30,000 IU), vitamin K (2,500 IU); thiamin (2,000 mg); riboflavin (600 mg); pyridoxine (4000 mg); niacin (40,000 mg); vitamin B_{12} (20 mg); panthothenic acid (10,000 mg); folic acid (1,000 mg); biotin (80 mg); choline chloride (500 mg); manganese (96 g); zinc (60 g); iron (24 g); copper (6 g); iodine (1 to 4 g); selenium (24 g); cobalt (12 g); antioxidant (12 g).

Table 3. Performance of broilers fed dried garlic powder at varying levels.

Parameter	Dietary treatment				
	1	2	3	4	SEM
Av. Initial body wt (g/b)	57	57	57	57	-
Av. Final body wt (g/b)	2240[a]	2350[a]	2460[a]	2780[b]	0.03
Av. Daily gain (g/b/d)	38.98[a]	40.95[a]	42.90[a]	48.62[b]	0.54
Av. Daily feed intake (g/b/d)	106.02	105.75	103.15	102.58	3.63
Feed conversation ratio	2.72	2.68	2.45	2.11	0.52
Feed cost/kg gain (₦)	196.50[b]	189.50[b]	189.00[b]	150.60[a]	3.52

[ab]Row means with different superscripts are significantly different (P<0.05). g/b indicate gram per birds; g/b/d – gram per bird per day. Feed conversation ratio = feed/gain.

farmer is to maximize production. This means that returns from the sale of birds on the 0.75% level of dried garlic powder is the highest.

Results also showed that the effect of treatments on haematological parameters of the birds were not significant (P>0.05) see Table 4. Blood haematological indices have been shown to be major indices of physiological, pathological and nutritional status of an organism and changes in the constituent compounds of blood when compared to normal values could be used to interpret the metabolic stage of an animal, as well as the quality of feed the animal consumed (Ologhobo et al., 2008). This shows that dried garlic incorporation into the ration of broilers did not affect the normal haematological integrity of the birds. The haematological values observed in the present study fell within normal ranges for domestic chicken as reported by Balash et al. (1973). On the other hand, results showed that feeding dried garlic powder to broilers reduced serum cholesterol levels by 1.10, 10.27 and 33.98% in broilers that are on Treatments 2, 3 and 4 diets, respectively see Table 5. Birds on Treatment 4 had the least serum cholesterol level of 76.30, which differed significantly from values of 115.57, 114.29 and 103.70 observed for birds on Treatments 1, 2 and 3, respectively.

Garlic contains high levels of bioactive saponins which form insoluble complexes with cholesterol and inhibit intestinal absorption of endogenous and exogenous

Table 4. Mean values of blood haematology of broilers fed dried garlic powder.

Parameter	Dietary treatment				
	1	2	3	4	SEM
Haemoglobin (g/dl)	8.02	8.92	8.69	9.65	0.32
Packed cell volume (%)	27.60	28.50	27.40	29.00	0.66
Red blood cell ($\times 10^3/mm^3$)	2.06	2.13	2.15	2.16	0.05
White blood ($\times 10^3/mm^3$)	10.47	10.50	11.27	12.23	0.49
Lymphocytes (%)	62.33	69.67	66.00	65.00	2.85
Neutrophylls (%)	33.33	27.67	31.67	32.33	2.77

Table 5. Cholesterol and Blood Chemistry of Broilers fed dried garlic powder.

Parameter	Dietary treatment				
	1	2	3	4	SEM
Cholesterol (mg/dl)	115.57^a	114.29^a	103.70^a	76.30^b	6.62
ALT (U/L)	5.27	4.22	5.07	5.29	0.76
AST (U/L)	85.58	82.81	85.68	80.75	1.71
Alkaline phosphatase (U/L)	188.16	191.94	192.97	200.43	2.61
Serum creatinine (mg/dl)	0.53	0.60	0.50	0.51	0.01
Blood urea (mg/dl)	14.85	14.77	14.93	14.61	0.35
Serum bilirubin (mg/dl)	0.21	0.22	0.21	0.20	0.01

^{ab}Row means with different superscripts are significantly different ($P<0.05$). SEM – Standard error of mean.

cholesterol (Oakenfull and Didhu, 1990). These key saponins in garlic also possess the ability to inhibit key enzymes in the cholesterol and lipid biosynthetic pathways (Konjufca et al., 1997). There is also evidence in the literature that garlic has cholesterol-lowering effect in humans and animals due to the presence of sulphur-containing bioactive compounds in its homogenates (Silagy and Neil, 1994; Neil et al., 1996; Chowdhury et al., 2002). This cholesterol lowering activity of garlic is believed to be as a result of allicin. When raw garlic bulb is chopped or crushed, the enzyme allinase activates allinin, a non protein amino acid present in the intact garlic to produce allicin (allyl 2-propenethiosulphinate or dially thiosulphinate) (Ologhobo et al., 2008). The cholesterol-reducing effect of garlic powder observed in the present study is in harmony with the previous work of Mirhadi et al. (1992) that allicin significantly inhibited hypercholesterolemia, reduced tissue cholesterol, lowered low density lipoprotein concentration (LDL or bad cholesterol), raised high density lipoprotein concentration (HDL or good cholesterol). Allicin also inhibits the action of hydroxymethly gutaryl – CoA reductase, which is the most important enzyme that participates in the synthesis of cholesterol and lipids. This is tandem with the findings of Vidica et al. (2011). Again, this cholesterol-lowering ability of garlic is of a very strong practical application. It follows that incorporation of 0.75% garlic in the diet of broilers will help reduce drastically the level of cholesterol in the meat. This will no doubt restore the confidence of consumers who earlier had withdrawn or halved their consumption of chicken because of cholesterol scare. This feeding approach will save the consumer from the negative effect of cholesterol, which include heart attack, stroke and obesity.

Although the blood chemistry indices observed where not significant, the observed numerical increase in the ALP and ASP values are of interest. These values are reflections of liver activity. As earlier observed, garlic contains a vast array of phytochemicals. On ingestion, these phytochemicals are detoxified or metabolized in the liver. The resultant increased activity of the liver, with increasing levels of garlic accounts for the observed increase in these blood chemistry indices.

Conclusion

Dried garlic powder incorporation in diets of broilers results in better performance, reduced serum cholesterol and maintains the haematological and serum chemistry integrity of the broilers.

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