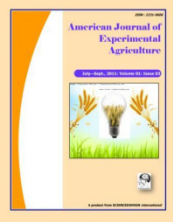

American Journal of Experimental Agriculture
4(11): 1410-1419, 2014

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Effects of Soyabean Oil and Garlic-in-Water Supplementation on Performance, Carcass Trait, Organs Weight, Haematology and Serum Cholesterol Content of Finisher Broiler Chickens

O. B. Jegede[1], G. E. Onibi[2] and O. A. Ogunwole[1*]

[1]Department of Animal Science, University of Ibadan, Ibadan, Nigeria.
[2]Department of Animal Production and Health, Federal University of Technology, Akure, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Author GEO designed the study and wrote the protocol. Author OBJ performed the broiler trial, laboratory and statistical analyses and undertook the first draft of manuscript while author OAO interpreted the data, managed the literature searches, edited and fine tuned the manuscript. All authors read and approved the final manuscript.

Original Research Article

Received 31st March 2014
Accepted 4th June 2014
Published 25th June 2014

ABSTRACT

A four weeks feeding trial was conducted using 160 four-week old Arbor acre chickens to assess the effects of soyabean oil and garlic (*Allium sativum*) in-water on performance, carcass characteristics, organs weight, haematological variables and serum cholesterol content of broiler birds. They were allotted to 4 treatments of 10 birds (5 males and 5 females) per replicate in a 2×2 factorial arrangement in which there were two diets (non-soyabean oil and soyabean oil diets) with or without garlic supplementation in drinking water. The final live weight of birds were significantly ($P<0.01$) increased by the dietary treatments with broilers fed soyabean oil-based diet having significantly ($P<0.05$) higher weight gain than those fed the non-soyabean oil diet. Also, birds without garlic supplementation consistently had higher weight ($P<0.01$) than those offered garlic in drinking water. The water intake of birds given water supplemented with garlic (5.54; 5.64

**Corresponding author: Email: droaogunwole@gmail.com;*

L/bird) was significantly (P<0.05) lower than those without garlic supplementation (5.95; 5.83 L/bird). The haematological variables, serum cholesterol content, carcass characteristics and relative organs weight of the chickens were not significant different (P>0.05). The interactions of dietary oil supplementation and garlic-in-water was not significant (P>0.05) for all measured indices. Conclusively, supplementation of diet with soyabean oil led to better broiler performance and garlic-in-water failed to neither lower abdominal fat deposition nor reduce serum cholesterol.

Keywords: Broilers performance; garlic-in-water supplementation; serum cholesterol; relative organs weight and abdominal fat; primal cuts.

1. INTRODUCTION

The poor performance of livestock in Africa has been largely attributed to inadequate and imbalanced nutrition, high price and poor quality feeds and inefficiency in production and distribution in the feed industry which has greatly reduced animal protein supply [1].

Currently, healthy eating trend is in favour of natural products. Natural feed supplements such as plant oils like soyabean oil with low fat content and perceived growth-enhancing herbs are commonly used by poultry producers to improve performance. Soyabean oil is known to contain high proportions of unsaturated fatty acids which are believed to reduce heart related diseases. One of the widely used natural supplements to maintain and improve health of humans is garlic [2]. It serves as antioxidant, anti-ageing and antihypertensive [3]. It has a strong stimulating effect on the immune system and aromatic oils present in it enhance bird's digestion [4].

Allicin, the major active ingredient in garlic has a repulsive odour and pungent taste which makes it unpopular in human nutrition. Report [5] indicated that supplementary garlic at 500mg/kg feed in diets of broiler chickens had no adverse effect on performance characteristics but reduced belly fat deposition and improved meat quality by reducing the production of toxic secondary lipids oxidation products, especially malonaldehyde. Similarly, reduction in intramuscular fat of broilers fed crushed fresh garlic at 0.3% of the ration has been reported [6].

However, report [7] indicated that laborious processes were involved in preparation of garlic powder and its subsequent incorporation into feeds. Therefore, it is conceivable that the addition of garlic in drinking water of broilers could be a way of exploiting the natural potentials of garlic to humans through broiler meat since monogastric animals have the ability to incorporate dietary components directly into their tissues. This study was therefore aimed at evaluating the effects of soyabean oil and garlic-in-water supplementation on performance, carcass trait, organs weight, haematology, and serum cholesterol content of broiler chickens.

2. MATERIALS AND METHODS

Fresh garlic bulbs were blended with water into garlic slurry every day for the experimental chickens at 1.8g/L of water. A total of 160 four-week old Arbor acre broiler chicks were randomly distributed into 4 treatment groups of 10 birds (5 males and 5 females) per replicate in a 2×2 factorial arrangement in which there were 2 diets (non-soyabean oil and

soyabean oil diets) with or without garlic supplementation in drinking water. Birds were placed on their respective experimental diets and fed *ad libitum* for four weeks during which weekly feed intake, water intake, weight changes and mortality were measured.

Two female broilers were randomly selected from each replicate and sacrificed by severing the carotid arteries with subsequent exsanguinations. Feathers were removed after scalding and the birds were cut opened, eviscerated, the internal organs harvested and separated. The live weight, bled weight and dressed weight were taken. Birds were carefully dissected in to primal cuts and each weighed and expressed as percentage of live weights. The internal organs and abdominal fat were also weighed and the weights expressed as percentage of live weights of the birds.

Blood samples were obtained from the jugular vein of two birds per replicate at the end of four weeks of feeding with syringe and needle into bottles containing anticoagulant (ethylene diamine tetra acetate; EDTA) for haematological samples while those for serum cholesterol were collected in bottles without EDTA. Serum was separated from the clotted blood and centrifuged into clean bottles. Determination of haemoglobin concentration was undertaken using cyano methaemoglobin method and packed cell volume was as described [8]. Red blood cell count was by haemocytometer method [9]. Total leucocytes counts were determined with Neubauer haemocytometer after appropriate dilution. Blood constants (mean cell volume, mean cell haemoglobin, mean cell haemoglobin concentration) were calculated using appropriate formulae [10]. Serum Total cholesterol concentrations was determined by enzymatic methods [11]. Feed and garlic samples were analysed [12].

Data collected were subjected to analysis of variance in a 2×2 factorial arrangement and the means where significant (α0.01 and α0.05) were separated with Duncan multiple range test. The Minitab Statistical Package (v.10.2, Minitab Inc. USA) was used for the analysis.

Metabolizable energy (ME) content of the diets was calculated from the chemical composition [13].

3. RESULTS AND DISCUSSION

The proximate composition of garlic and experimental diets as shown in Table 1 revealed that the crude fibre content of garlic was 2.40% which is similar to the value of 2.10% crude fibre reported for garlic [14]. The crude protein (CP) content of the garlic was 20.03%. Earlier documentation by [15] and [13] indicated CP values of 17.35% and 15.30% respectively for garlic. The calculated crude protein of the finisher non-soyabean oil diet (19.62%) and soyabean oil diet (19.80%) in Table 1 were similar to the analyzed crude protein of 19.41% and 19.52% for non-soyabean oil and soyabean oil diets respectively.

Table 2 shows the final live weight of the birds and total weight gain were significantly ($P<0.01$) affected by the dietary treatments with broilers fed soyabean oil-based diet having significantly ($P<0.05$) higher weight gain than those fed the non-soyabean oil diet which agreed with earlier report [16]. Also, birds on without garlic supplementation consistently had higher values ($P<0.01$) than those offered garlic in drinking water which is consistent with earlier observation (17). However, in this current study, interactions between diets and garlic supplementation were not significant ($P>0.05$).

Table 1. Composition (%) of experimental diets

Ingredients	Diets	
	Non-soyabean oil	Soyabean oil
Maize	48.00	40.00
Maize offal	15.00	18.00
Soyabean meal	14.00	14.00
Groundnut cake	14.00	14.00
Brewers Dried grain	5.25	8.25
Bonel meal	2.00	2.00
Limestone	0.50	0.50
Salt	0.50	0.50
Premix	0.25	0.25
Methionine	0.30	0.30
Lysine	0.20	0.20
Soyabean oil	-	2.00
Total	100.00	100.00
Calculated		
Crude Protein %	19.02	19.80
ME kcal/kg	2911.40	2941.60
Analyzed (%)		Garlic
Crude Protein	19.41	19.52
		20.03
Crude fibre	5.85	6.05
		2.40

**Broiler finisher premix contains per kg, Vit. A (400,000 i.u)Vit. D3 (800,000 i.u), Vit. E (9,200 i.u), Niacin (11,000 mg), Vit.B1(720 mg), Vit.B2 (2000 mg), Vit. B6 (1,200 mg), Vit. B12 (6 mg), Vit. K3 (800 mg), Panthotenic acid (3000 mg), Biotin (24 mg), Folic acid (300 mg),Choline chloride (120,000 mg), Cobalt (80 mg), Copper (1,200 mg), Iodine (400 mg), Iron (8000 mg), Manganese (16,000 mg), Selenium (80 mg), Zinc (12,000 mg)*

Similarly, the total weight gain was significantly influenced by diet ($P<0.05$) and garlic supplementation ($P<0.01$) but the interaction of the two factors was not significant ($P>0.05$). In addition, the feed intake of birds fed soyabean oil-based diet, though not significant ($P>0.05$), were slightly lower than those fed non-soyabean oil-based diet; while birds offered garlic-supplemented water had higher feed intake compared to those on no garlic supplementation which confirmed similar reported observation [18]. However, the feed conversion ratio (FCR) was not significantly influenced by the diet, garlic supplementation and the interaction of the two factors but FCR values of birds fed soyabean oil-based diets (2.46 and 2.54) were lower than those fed non-soyabean oil-based diets (2.56 and 3.01) for non-garlic and garlic-in-water supplementation, respectively ($P<0.05$). Table 2 also shows that the water intake was significantly ($P<0.05$) influenced by garlic supplementation and not by diet and the interaction between two factors. The water intake of the experimental birds given water supplemented with garlic was significantly ($P<0.05$) lower than those offered water without garlic supplementation. This could be attributed to the pungent and repulsive odour of garlic which perhaps reduced the water intake. Also, apparent digestibility of crude protein (ADCP) was not significantly ($P>0.05$) influenced by the diet, garlic supplementation and the interaction of the factors.

Table 2. Performance of broiler finishers fed diets containing soyabean oil with or without garlic-in-water supplementation

Diet	Garlic supplementation	Initial LW (Kg/bird)	Final LW (Kg/bird)	Total weight gain (Kg/bird)	Daily weight gain (g/bird)	Total feed intake (Kg/bird)	Daily feed intake (g/bird)	Feed conversion ratio	Total water intake (L/day/bird)	Daily water intake (ml/bird)	ADCP (%)
Non-soyabean oil	No Garlic	0.72±0.03	2.37±0.06	1.64±0.06	58.57±2.16	4.19±0.11	149.55±4.04	2.56±0.12	5.95±0.39	212.34±13.81	83.99± 6.04
	With Garlic	0.72±0.02	2.25±0.03	1.44±0.12	51.43±4.23	4.29±0.60	153.20±21.4	3.01±0.62	5.54±0.26	197.68±9.29	77.91±16.02
Soyabean oil	No Garlic	0.72±0.02	2.39±0.03	1.67±0.03	59.73±1.14	4.11±0.07	146.79±2.62	2.46±0.04	5.83±0.25	208.33±8.92	69.39±10.34
	With Garlic	0.72±0.12	2.36±0.04	1.63±0.03	59.73±1.14	4.14±0.19	147.68±6.59	2.54±0.15	5.64±0.15	201.49±5.22	70.38±14.64
Statistical significance											
Diet		NS	**	*	*	NS	NS	NS	NS	NS	NS
Garlic supplementation		NS	**	**	**	NS	NS	NS	*	*	NS
Diet x Garlic Supplementation		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Mean separation											
Dietary effect	NSO	0.72±0.02	2.31±0.08^{b}	1.54±0.14^{b}	55.00±4.92^{b}	4.24±0.40	151.38±14.38	2.78±0.48	5.74±0.38	205.01±13.42	80.59±11.92^{a}
	SO	0.72±0.02	2.37±0.04^{a}	1.65±0.05^{a}	58.97±1.73^{a}	4.12±0.13	147.23± 4.67	2.50±0.11	5.74±0.22	204.91± 7.69	79.88±11.75^{b}
Garlic supplementation effect	No Garlic	0.72±0.02	2.38±0.04^{a}	1.66±0.05^{a}	59.15±1.72^{a}	4.15±0.10	148.17± 3.49	2.51±0.10	5.89±0.31^{a}	210.33±10.98^{a}	76.69±11.06^{a}
	With Garlic	0.72±0.02	2.30±0.07^{b}	1.54±0.13^{b}	54.82±4.75^{b}	4.21±0.42	150.45±14.94	2.77±0.49	5.59±0.20^{b}	199.58± 7.27^{b}	73.78±14.78^{b}

*Mean ± SD, n=8; NS=Not significant (P>0.05), *=P<0.05, **=P<0.01; NSO= Non-soyabean oil diet; SO=Soyabean oil diet; ADCP= Apparent digestibility of crude protein; Mean with different superscripts within the same column and for the same parameter are significant (P<0.05)*

Table 3. Carcass characteristics of broiler finishers fed diets containing soyabean oil with or without garlic-in-water supplementation

Diet	Garlic supplementation	g/kg live weight										
		Dressing %	Eviscerated %	Back	Breast	Drumstick	Thigh	Wings	Neck	Head	Shank	Abdominal Fat
Non-soyabean oil	No Garlic	92.35±1.36	79.27±2.50	160.78±11.00	203.04±19.79	104.66±5.34	111.10±6.64	83.21±7.03	46.56±6.23	25.45±1.84	37.16±3.09	19.15±7.47
	With Garlic	92.80±1.02	78.57±1.32	179.40±19.36	194.00±22.31	99.60±8.01	106.47±4.37	84.34±6.63	45.27±6.07	26.18±2.71	36.08±5.53	18.92±10.89
Soyabean oil	No Garlic	92.17±1.47	79.76±2.17	165.01±14.42	212.59±25.39	100.00±7.52	112.61±4.15	81.33±5.25	44.84±9.15	23.75±1.91	34.35±2.90	19.75±4.17
	With Garlic	93.46±1.08	80.73±1.85	181.50±16.67	213.81±13.49	99.78±13.49	110.76±6,18	81.14±3.63	40.97±4.51	40.97±4.51	34.65±2.78	18.38±6.71
Statistical significance												
Diet		NS	NS	NS	*	NS	NS	NS	NS	NS	NS	NS
Garlic Supplementation		NS	NS	***	NS	NS	NS	NS	NS	NS	NS	NS
Diet x Garlic Supplementation		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Mean separation												
Dietary effect	NSO	92.57±1.18	79.92±1.96	170.09±17.99	198.52±20.90^{b}	102.13±7.08	108.79±5.93	83.21±7.03	45.91±6.29	25.82±2.27	36.62±4.36	19.03±9.02
	SO	92.81±1.42	80.24±2.01	173.26±17.30	213.20±19.65^{a}	99.89±5.43	111.68±5.17	81.23±4.36	42.90±7.25	24.33±2.23	34.50±2.75	19.07±5.44
Garlic supplementation effect	No Garlic	92.26±1.37	79.52±2.28	162.89±12.58^{b}	207.82±22.54	102.33±6.75	111.86±5.41	82.27±6.07	45.70±7.61	24.60±2.01	35.76±3.24	19.45±5.85
	With Garlic	93.13±1.07	79.65±1.91	180.45±17.48^{a}	203.90±20.54	99.69±5.74	108.62±5.62	82.74±5.42	43.12±5.95	25.54±2.61	35.36±4.29	18.65±8.74

*Mean ± SD, n=8, NS=Not significant (P>0.05), *=P<0.05, ***=P<0.001. NSO= Non-soyabean oil diet; SO=Soyabean oil diet Mean with different superscripts within the same column and for the same parameter are significant (P<0.05)*

Table 4. Organ weight (g/kg live weight) of broiler finishers fed diets containing soyabean oil with or without garlic-in-water supplementation

Diet	Garlic supplementation	g/kg live weight					
		Proventriculus	**Gizzard**	**Liver**	**Heart**	**Spleen**	**Pancreas**
Non-soyabean oil	No Garlic	3.84±0.44	15.10±2.17	17.27±1.52	3.99±0.30	1.07±0.30	2.05±0.50
	With Garlic	3.61±0.98	16.91±3.13	18.25±1.58	4.07±0.47	1.07±0.37	1.96±0.34
Soyabean oil	No Garlic	3.29±0.72	14.80±2.15	18.25±1.58	3.47±0.53	0.90±0.19	2.08±0.66
	Wo Garlic	3.34±0.67	16.14±2.53	17.78±1.51	3.53±0.32	0.88±0.31	1.86±0.45
Statistical significance							
Diet		NS	NS	NS	***	NS	NS
Garlic supplementation		NS	NS	NS	NS	NS	NS
Diet x Garlic supplementation		NS	NS	NS	NS	NS	NS
Mean separation							
Dietary effect	NSO	3.74±0.75	16.44±2.65	17.76±1.58	4.03±0.38[a]	1.07±0.32	2.00±0.41
	SO	3.32±0.67	15.47±2.37	17.67±1.53	3.50±0.43[b]	0.89±0.25	1.97±0.56
Garlic supplementation	No Garlic	3.58±0.65	15.39±2.17	17.42±1.54	3.73±0.50	0.98±0.20	1.97±0.56
effect	With Garlic	3.48±0.83	16.52±2.78	18.01±1.52	3.80±0.48	0.98±0.34	1.91±0.39

*Mean ± SD, n=8; NS=not significant (P>0.05), ***P<0.001; NSO= Non-soyabean oil diet; SO=Soyabean oil diet; Mean with different superscripts within the same column and for the same parameter are significant (P<0.05)*

Table 5. Blood indices and serum cholesterol contents of broiler fed diets containing soyabean oil with or without garlic-in-water supplementation

Diet	Garlic Supplementation	PCV (%)	RBC ($10mm^3$)	Hb (g/100ml)	MCHC (%)	MCH (pg)	MCV (μ^3)	ESR (mm/hr)	Lymphocyte (%)	Neurothrophil (%)	Monocyte (%)	Serum cholesterol (mg/dl)	Eosinophil (%)
Non-soyabean oil	No Garlic	29.38±2.13	1.93±0.23	9.79±0.73	33.31±0.10	50.96±3.32	152.96±9.99	3.00±1.31	56.63±3.96	25.75±1.83	14.50±3.38	140.90±41.30	1.13±0.35
	With Garlic	30.75±1.49	2.10±0.15	10.31±0.57	33.53±0.47	49.21±1.82	146.75±4.93	2.56±0.82	58.12±3.60	24.25±1.83	14.63±3.62	136.60±59.30.	1.00±0.00
Soyabean oil	No Garlic	30.13±2.23	2.01±0.17	10.08±0.75	33.44±0.37	50.13±2.78	149.83±6.73	2.50±1.00	59.38±2.72	24.38±1.92	13.00±2.39	145.80±33.70	1.13±0.35
	With Garlic	29.00±2.73	1.96±0.30	9.66±0.91	33.32±0.07	49.76±3.58	149.36±10.72	3.00±1.34	58.00±4.28	24.88±2.53	13.88±3.00	130.40±24.80	1.13±0.35
Statistical significance													
Diet		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Garlic supplementation		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Diet x Garlic Supplementation		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Mean Separation													
Dietary effect	NSO	30.06±1.91	2.02±0.20	10.05±0.69	33.42±0.35	50.08±2.74	149.85±8.26	2.78±1.08	57.38±3.74	25.00±1.93	14.56±3.39	138.80±45.80	1.06±0.25
	SO	29.56±2.48	1.99±2.48	9.87±0.83	33.38±0.27	49.95±3.10	149.60±8.65	2.75±1.17	58.69±3.54	24.63±2.19	13.44±2.26	137.00±27.50	1.13±0.34
Garlic supplementation effect	No Garlic	29.75±2.15	1.97±0.20	9.93±0.73	33.38±0.27	50.54±2.99	157.39±8.39	2.75±1.16	58.00±3.58	25.06±1.95	13.75±2.93	143.40±33.80	1.13±0.34
	With Garlic	29.88±2.31	2.03±0.24	9.99±0.80	33.42±0.34	49.49±2.76	148.06±8.17	2.78±1.10	58.06±3.82	24.56±2.16	14.25±3.24	133.00±38.60	2.06±0.25

Mean ± SD, n=8; NS=Not significant (P>0.05). NSO= Non-soyabean oil diet; SO=Soyabean oil diet

*Mean ± SD, n=8; NS=not significant (P>0.05), ***P<0.001; NSO= Non-soyabean oil diet; SO=Soyabean oil diet; Mean with different superscripts within the same column and for the same parameter are significant (P<0.05)*

Table 3 showed that the dressing percentage, eviscerated weight, drum stick, thigh, wings, neck, head, shank and the abdominal fat were not significantly (P>0.05) influenced by diet, garlic supplementation and the interaction of the two factors which conformed to earlier observation [19]. Supplementary garlic-in-water significantly (P<0.001) increased the back weight of the chickens, while the breast of birds fed soyabean oil was significantly (P<0.05) higher than those fed non-soyabean oil. However, the drum stick and thigh were not significantly influenced (P>0.05) by the diet, garlic supplementation and the interaction of the two factors. Also, garlic-in-water supplementation only reduced abdominal fat deposition numerically from 19.15 to 18.92 and 19.75 to 18.38 g/kg live weight. This observation was contrary to the report on the likelihood of supplemental garlic in reducing fat deposition [20].

The results from Table 4 showed that the diet, garlic supplementation and the interaction of both did not significantly (P>0.05) influence the weights of proventriculus, gizzard, liver, spleen and pancreas. This study conformed to previous reports by authors [19,21]. However, the weight of heart was significantly (P<0.001) influenced by diets and not by garlic supplementation or the interactions of both. It was observed that the heart of birds fed soyabean oil diet had significantly (P<0.001) lower value (3.05±0.43g/kg live weight) than those of birds fed non-soyabean oil diet (4.03±0.38g/kg live weight). However, it was observed that the numerical relative weights of all the organs of birds fed soyabean oil were lower than those fed non-soyabean oil diet. Similar organ development was obtained for birds offered garlic or no garlic in drinking water.

Table 5 also showed that the haematological variables and the serum cholesterol content of the chickens were not significantly (P>0.05) affected. The haematological values were within the reported range [22]. Addition of soyabean oil to diets and garlic-in-water supplementation numerically lowered serum cholesterol level (140.9 vs. 136.6; 145.8 vs 130.4 mg/dl). Furthermore, the serum cholesterol level of birds offered supplementary garlic had lower numerical value though not statistically significant (P>0.05) compared to those given water without garlic supplementation in agreement with earlier similar observation [23].

4. CONCLUSION

The final live weight, breast and back weights of broilers fed soyabean diet were improved by soyabean oil and garlic supplementation. Though, haematological parameters of broiler chickens were not influenced by soyabean oil and garlic-in-water supplementation. Therefore, supplementation of soyabean oil in the diet led to better broiler performance and garlic-in-water neither reduced the abdominal fat deposit nor serum cholesterol.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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