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Full Length Research Paper

Effect of diets fortified with garlic organic extract and streptomycin sulphate on growth performance and carcass characteristics of broilers

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An experiment was carried out to study the comparative effects of garlic organic extract and streptomycin sulphate on growth performance and carcass characteristics of broilers. Forty-eight *Hubbard* line day-old chicks with equal numbers of males and females were randomly allocated to eight (8) treatment combinations to conduct a 4×2 factorial experiment in a completely randomised design. The diets were supplemented with: no supplement (control), garlic organic extract at 40 ppm/kg (GOE 40 ppm), garlic organic extract at 60 ppm/kg (GOE 60 ppm) and streptomycin sulphate at 30 ppm/kg (SS 30 ppm) administered by oral gavages from day 13 to day 47 of experiment. The results showed that the growth performance attributes of birds on supplementation with streptomycin sulphate and garlic organic extract did not differ, but were significantly better (P<0.05) than the values obtained from birds on control. The same observation was made for the carcass characteristics. Male broilers yielded heavier (P<0.001) carcasses (1748.50 vs 1533.50 g), higher (P<0.05) relative heart weight (0.43 vs 0.40% body weight), and deposited less (P<0.001) abdominal fat compared with the females (0.27 vs 0.76% body weight). Treatment and sex interaction significantly affected all the parameters studied except for the heart, pancreas and head. In summary, diets supplemented with garlic organic extract at 40 ppm could be used as an alternative to antibiotic additives for broiler production.

Key words: Broilers, carcass characteristics, garlic organic extract, growth performance, streptomycin sulphate, supplementation.

INTRODUCTION

Malnutrition and related diseases observed in some developing countries are mostly associated with protein and essential micronutrients deficiencies (Ambrus and Ambrus, 2004). FAO (1995) recommended a minimum animal protein intake of 35 g out of the 61 g total protein intake per caput per day. In Cameroon, the average animal protein intake (meat, milk, eggs and fish) has been estimated at 13.2 g with meat alone representing 6.8 g (ADB, 2008). In order to meet this minimum animal protein requirement for an increasing human population across the world, animal production over the years has been associated with the use of antibiotic growth promoters at low doses in animal diet. These feed antibiotics in use in this field since 1946 contributed to stabilise the intestinal microbiota, to prevent diseases of the gastro-intestinal tract and to improve upon growth performance (Waldroup et al., 1985). Despite the seemingly satisfactory

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Table 1. Composition of experimental starter and finisher diets.

Ingredient	Starter	Finisher
Maize (7.6% CP)	51.25	56.80
Rice bran (11.8% CP)	08.00	10.00
Soybean meal (44% CP)	33.50	30.00
Fish meal (72% CP)	3.50	------
Bone meal	3.00	2.50
Vitamin/Mineral premix[k] (0.25%)	0.25	0.25
Sodium chloride (NaCl)	0.30	0.25
Methionine (99%)	0.20	0.20
Total (kg)	100.00	100.00
Feed nutrients proximate analysis		
Metabolizable energy (Kcal/kg)	2818.33	2855.37
Crude protein (%)	22.05	19.08
Crude fibre (%)	4.21	4.31
Fats (%)	4.58	6.31
Calcium (%)	1.02	1.00
Available Phosphorus (%)	0.49	0.47
Lysine (%)	1.25	1.03
Methionine (%)	0.58	0.51

[k] Each 2.5 kg premix contained the followings: Vit A 10,000,000 IU; Vit. D_3 3,000,000 IU; Vit. E 30,000 IU; Vitamin K_2 3 g ; Vit B_1 1.7 g; Vit B_2 5.0 g; Vit B_6 3.1 g; Vit B_{12} 16 mg; Biotin 60 mg; Niacin 1.0 g; Pantothenic Acid 8 g; Folic Acid 0.8 g; Manganese 85 g; Zinc 50 g; Iron 25 g; Copper 6 g; Iodine 1.1 g; Selenium 120 mg; Cobalt 220 mg; B.H.T 60 g; Ethoxyquin 65 g; Choline Chloride 200 g.

results obtained in poultry industries with antibiotic growth promoters, increased anti-microbial resistance (Jang et al., 2007) and other related health problems to the consumers were reported (Kato et al., 2001; Donoghue, 2003; Pasteiner, 2006). This situation led to the ban of these products by the European Union in January, 2006 thereby giving room to a search for natural alternatives. The present study was therefore designed to evaluate the effect of garlic organic extract and streptomycin sulphate on the growth performance and carcass characteristics of broiler chickens.

MATERIALS AND METHODS

Diets and feeding regimens

Birds were fed with commercial starter and finisher diets (NRC, 1994) formulated to meet their nutrient requirements throughout the experiment (Table 1).

As for the supplement, garlic extract was obtained by organic solvent extraction (Soxhlet, 1879) and oil analysis was carried out according to Adams (2001) method (Table 2).

Birds husbandry

Forty-eight day old chicks of *Hubbard* line with equal numbers of males and females were selected from the batch kept in a brooding room of Abubakar Tafawa Balewa University Poultry Research Farm, Bauchi State, Nigeria for two weeks and transferred to experimental pens. The brooding room temperature decreased from 32°C during the first week of life to 28°C in the second. The chicks were given an anti-stress agent from the first to the third day of age and before, during and after vaccinations and treatments. In order to boost their immunity, they were vaccinated against infectious bursal disease on the fourteenth day of the experiment while Newcastle disease vaccine was administered at 21 days of age. Experimental diets and water were given to birds *ad libitum* every day. The entire flock was subject to deworming on the 35th day of age using piperazine.

The experiment lasted for five weeks during which feed intake, weekly weight gain and feed conversion ratio were monitored. Brownish faeces were observed in the fourth week of experiment and the whole flock was thereby subject to five (5) days of cure against coccidiosis with pure amprolium coupled with anti-stress administration. At slaughther, carcass and relative organ weights evaluation were carried out according to Fletcher (1999).

Experimental design, data extraction and statistical analysis

The forty-eight *Hubbard* line day-old chicks with equal numbers of males and females were allocated in a 4×2 factorial experiment with diet having four (4) levels [Control(water), GOE_{40}, GOE_{60}, SS_{30}] and sex having two levels (male, female) thereby giving eight treatment combinations in which garlic organic extract (GOE) and streptomycine sulphate (SS) were supplemented to the basal diet by oral intubation at the following doses: garlic organic extract 40 to 60 mg/kg/day and Streptomycin sulphate 30 mg/kg/day [(Fraser et al., 1991; Radostits et al., 1997; Group Zhongnuo Pharmaceutical (Shijiazhuang) Co., Ltd.)]. Oral gavages started when the chicks

Table 2. Chemical composition (%) of the garlic extract.

No.	Retention index	Compound Name	Percent in oil
		Thioethers	**83.67%**
1	660	Allyl methyl sulfide	3.49
2	849	1-propene, 3,3'-thiobis-sulfide	3.99
3	1099	Disulfide, di-2-propenyl	9.78
4	1131	Trisulfide, methyl 2-propenyl	26.82
5	1134	3-vinyl-1,2-dithiacyclohex-5-ene	32.72
6	1350	Trisulfide, di-2-propenyl	6.86
		Fatty acid	**16.33%**
7	1968	n-hexadecanoic acid	6.51
8	2183	Linoleic acid	9.82

Table 3. Effects of garlic organic extract and streptomycin sulphate supplementations on the growth performance of broiler chickens.

Parameter	Control	Garlic organic extract		Streptomycin (30 ppm)	SEM	P value
		40 ppm	60 ppm			
Daily feed intake (g/bird)	94.06[b]	109.11[a]	107.44[a]	110.52[a]	11.51	0.015
Initial body weight (g)	185.83	201.58	205.50	198.66	4.25	0.731
Final body weight (g)	1517.00[c]	1638.00[b]	1647.00[b]	1762.00[a]	50.05	0.001
Daily weight gain (g/bird)	38.04[b]	47.49[a]	48.31[a]	50.07[a]	6.23	0.050
Feed conversion ratio	2.48[a]	2.33[b]	2.27[b]	2.24[b]	0.083	0.025
Number of deaths	0	0	1.00	1.00		

[a, b] Mean values in the same row with different superscripts are significantly different.

were 13 days old and ended at day 47. Each of the eight treatment combinations obtained had two birds (males or females) replicated three times in twenty-four (24) experimental units of a completely randomised design in deep litter pens. Weekly weighings of birds were carried out to determine the concentration of treatments to be given to birds. The quantity of garlic oil and streptomycin sulphate administered were calculated taking into account the proportion of the major oil component, the minimum recommended oral route dose of the antibiotic and the chicken live weights. The data collected were compared using the analysis of variance (ANOVA) option of Minitab (version 11.0) and Compare Means option of Statistical Package for Social Sciences software (version 11.0) as described by Steel and Torrie (1980). Significantly different means among treatments were separated using Duncan's Multiple Range Test (Duncan, 1955) at ($P<0.05$).

RESULTS

Growth performance attributes of birds

The overall growth performance of broilers from the 13th to the 47th day of trial is presented in Table 3. The highest daily feed intake (DFI) of 110.42 g was observed in streptomycin sulphate supplemented group while the lowest was 94.06 g found in the control group. The values of daily feed intake among birds on supplemented diets were statistically similar, but were all significantly higher ($P<0.05$) than those obtained from birds on the basal diet. The daily weight gain (DWG) varied from 38.04 g in the control group to 50.07 g in diets supplemented with streptomycin sulphate. There was no significant difference between the weight gains of birds on supplementation with garlic extract and streptomycin sulphate but these values were significantly higher ($P<0.05$) than the value recorded in birds on the control diet. Likewise, the values of feed conversion ratio (FCR) obtained from birds on garlic extract and streptomycin sulphate did not differ, but were significantly higher ($P<0.05$) than those found in birds on control.

Carcass characteristics and relative organs weight

Table 4 presents the carcass characteristics and organ weights expressed in proportion of body weight of broilers. The highest means of live weight, plucked weight, eviscerated weight and carcass weight were found in birds on streptomycin sulphate supplementation and significantly differed ($P<0.01$) from the lowest values recorded in the control group while those in garlic oil 60 ppm and garlic oil 40 ppm supplementations were all statistically similar.

Table 4. Effects of garlic organic extract and streptomycin sulphate supplementations on carcass characteristics and relative organs weight of broiler chickens.

Parameter	Control	Garlic organic extract		Streptomycin (30 ppm)	SEM	P value
		40 ppm	60 ppm			
Live weight (g)	1517.00^{c}	1638.00^{b}	1638.00^{b}	1762.00^{a}	15.09	<0.001
Plucked weight (g)	1392.37^{c}	1505.25^{b}	1505.25^{b}	1603.37^{a}	11.74	<0.001
Eviscerated weight (g)	1176.50^{c}	1295.00^{b}	1295.00^{b}	1373.75^{a}	14.60	<0.001
Carcass weight (g)	1063.37^{c}	1184.25^{b}	1184.25^{b}	1259.00^{a}	13.57	<0.001
Dressing percentage	70.39^{b}	72.29^{a}	72.29^{a}	71.35^{ba}	0.51	0.041
Relative organs weight (%BW)						
Heart	0.41^{ab}	0.44^{a}	0.43^{a}	0.38^{b}	0.017	0.032
Liver	2.28^{a}	2.17^{a}	2.13^{a}	1.83^{b}	0.122	0.001
Abdominal fat	0.79^{a}	0.48^{b}	0.39^{b}	0.41^{b}	0.058	<0.001
Pancreas	0.27	0.26	0.24	0.22	0.018	0.059
Gizzard	1.94	1.80	1.94	1.98	0.062	0.853
Legs	4.35^{a}	4.17^{ab}	4.09^{ab}	3.98^{b}	0.121	0.050
Head	2.76^{a}	2.63^{ab}	2.61^{ab}	2.51^{b}	0.064	0.044

$^{a, b, c}$ Mean values in the same row with different superscripts are significantly different.

The average values of dressing percentage of birds on garlic oil and streptomycin sulphate did not differ but were significantly higher (P<0.05) than those of birds on the basal diet. The relative organs weight of birds on diets fortified with streptomycin sulphate were significantly lower (P<0.001) for the liver compared with the values found in birds on garlic oil supplementation and the control group. The relative weights of liver in the control group of birds were numerically higher than those found in birds on garlic supplementation but were both statistically similar. The highest value of the relative weight of the heart was found in birds on garlic oil 40 ppm and it was statistically similar to the value found in birds on the control group and Garlic oil 60 ppm supplementation, but was significantly higher (P<0.05) than the value in birds on diets fortified with streptomycin sulphate. The same observation was made for the relative weight of the legs.

In the same vein, the highest value of relative weight of the head was found in birds on the control group and it was statistically similar to the value in birds on garlic oil 40 ppm supplementation, but was significantly different (P<0.05) from the lowest value found in birds on streptomycin sulphate supplementation. These values were statistically similar among birds on garlic extract supplementation. There were no significant differences among the relative weights of pancreas and gizzard in all the groups. The values of relative weight of abdominal fat pad did not differ among birds on supplemented diets, but were significantly lower (P<0.001) than those in birds on the control diet.

The relative abdominal fat value recorded in broilers on garlic extract 60 ppm was half the value found in those on the basal diet indicating that garlic extract improved the meat quality. On the other hand, The average values of live weight, plucked weight, eviscerated weight, carcass weight and dressing percentage in the sex effects (Table 5) were significantly higher (P<0.001) in male birds than the females. Likewise, higher (P<0.05) relative heart weight was observed in male broilers but they had lower (P<0.001) abdominal fat deposit as compared with the females.

Treatment and sex interaction (Table 6) significantly affected (P<0.001) the live weight, plucked weight, eviscerated weight, carcass weight of broilers indicating that the two factors contributed synergistically to the increase in weight of birds. The interaction also affected all the relative weight of organs and offal studied except for the heart, the pancreas and the head. Even within the interaction**,** female group of birds still put on more fat (P<0.05) than the males and the relative weight of legs of males on garlic extract 40 ppm were higher (P<0.05) than those of females on the same treatment.

DISCUSSION

Diets supplemented with garlic organic extract and streptomycin sulphate improved upon the daily feed intake of broilers compared with the control. The same trend is observed in the report of Tchakounte et al. (2006) who studied the effects of feeding palm oil residue on the productive and economical performances of broiler chickens. Their results showed an improvement in performances with increasing levels of palm oil residue incorporation in the diets. Chicks fed diets containing 7% palm oil residue consumed significantly more (P<0.05) feed than those fed the control diet. The daily weight gain

Table 5. Sex effects on carcass characteristics, relative organs and offals weight.

Parameter	Male	Female	SEM	P value
Live weight (g)	1748.50	1533.50	25.72	<0.001
Plucked weight (g)	1613.12	1395.37	24.59	<0.001
Eviscerated weight (g)	1397.12	1183.68	24.15	<0.001
Carcass weight (g)	1276.68	1082.18	22.54	<0.001
Dressing percentage (%)	72.97	70.57	0.399	<0.001
Relative organs weight (% BW)				
Heart	0.43	0.40	0.008	0.041
Liver	2.10	2.10	0.058	0.400
Pancreas	0.23	0.26	0.009	0.059
Gizzard	1.96	1.85	0.042	0.211
Abdominal fat pad	0.27	0.76	0.059	<0.001
Head	2.67	2.59	0.034	0.223
Legs	4.22	4.07	0.054	0.136

(DWG) varied from 38.04 g in the control group to 50.07 g in diets supplemented with streptomycin sulphate. There was no significant difference between the weight gains of birds on supplementation with garlic extract and streptomycin sulphate but these values were significantly higher (P<0.05) than the value recorded in birds on the control diet. Tchakounte et al. (2006) also found a significant difference (P<0.05) in weight gain between chicks fed 7% palm oil residue and those on the control diet. Birds on garlic extract supplemented diets had similar feed intake with those on diets supplemented with streptomycin sulphate and both were affected by the growth promoting effects of these diets. Likewise, Fotea et al. (2009) studied the effect of essential oil of rosemary (*Rosmarinus officinalis*) on the broilers growing performance and recorded that the level of 0.5% essential oil of rosemary can be considered a possible replacement for antibiotic growth promoter for chicken broilers. The values of feed conversion ratio (FCR) obtained from birds on garlic extract and streptomycin sulphate did not differ, but were significantly higher (P<0.05) than those found in birds on control.

This view is equally in harmony with the findings of Ademola (2003) who included penicillin and streptomycin at 100 ppm each to a low protein diet for broilers and observed better feed conversion ratio in birds on antibiotic fortified diets compared with the control.

As for the carcass characteristics and relative organ weights of broilers, the highest means of live weight, plucked weight, eviscerated weight and carcass weight of birds were found in birds on streptomycin sulphate and they all differed from the lowest value recorded in the control group while those of birds on garlic oil supplemented diets were all statistically similar. Birds on garlic organic extract and streptomycin sulphate supplementations did not differ in dressing percentage but they all had better values than those on the control. These results are consistent with those observed by Rajaian et al. (2006), who used *Berberis vulgaris* as growth promoter in broiler chickens and obtained significantly heavier (P<0.05) weight for birds on diet containing 1% berberis root powder compared with those in the control group. Similarly, Cornelison et al. (2006) evaluated the use of hops (*Humulus iupulus*) in broiler diets as a potential replacement for antibiotics and found at 42 days a significantly greater (P<0.05) body weight of birds fed with 0.5 Ibs of hops per ton of feed compared with those on the control diet.

Birds on supplemented diets achieved lower relative liver weight compared with those in the control group. The relative weight of gizzard and pancreas of birds did not differ in all the groups. In the same vein, the relative weight of the head and the legs of birds on garlic oil and streptomycin sulphate supplementations did not differ but were reduced compared with those of birds on the basal diet. The decrease in weight of liver of birds on supplemented diets contrast with the earlier report of Tchakounte et al. (2006) where liver and the gizzard of birds on supplemented diets were more developed (2.07±0.07% and 2.12±0.11%) than the standard value shown for the strain, thus indicating an intense activity of these organs.

On the other hand, fat deposit in broilers on the control diet was significantly higher than the values found in those on supplemented diets. Barbour et al. (2006) studied the effect of soybean oil supplementation to low metabolizable energy diets on production parameters of broiler chickens and observed a significant decrease (P<0.05) in percentage deposition of abdominal fat pad in birds on supplemented diets compared with those on the control. Likewise, male broilers deposited less abdominal fat than the females. This result is consistent with one of the exogenous factors affecting growth attributed to female birds whose feed intake is higher resulting in a

Table 6. Treatment × Sex interaction effects on carcass characteristics and relative organs weight of broiler chickens.

Parameter	Control		GOE 40 ppm		GOE 60 ppm		SS 30 ppm		SEM	P value
	♂	♀	♂	♀	♂	♀	♂	♀		
Live weight (g)	1575^{gfe}	1459^{h}	1755^{c}	1521^{g}	1764^{cb}	1530^{gf}	1900^{a}	1624^{ed}	13.617	<0.001
Plucked weight (g)	1454. 7^{e}	1330^{h}	1622.25^{c}	1388.25^{g}	1638.00^{cb}	1394.00^{gf}	1737.5^{a}	1469.25^{ed}	13.244	<0.001
Eviscerated weight g)	1238^{fed}	1114.5^{g}	1396.50^{b}	1193.50^{fe}	1447.00^{ba}	1185.75^{f}	1506.50^{a}	1241^{fedc}	15.568	<0.001
Carcass weight (g)	1125^{fed}	1011.7^{g}	1271.75^{b}	1097.25^{fe}	1328.75^{ba}	1083.00^{f}	1381.25^{a}	1136.7^{fedc}	15.232	<0.001
Dressing percentage	71.43^{gfe}	69.34^{h}	72.45^{fedc}	72.14^{fed}	75.32^{a}	70.79^{hgf}	72.70^{edcb}	70.00^{hg}	0.799	0.035
Relative organs and offals weight (%BW)										
Heart	0.41	0.41	0.45	0.42	0.46	0.40	0.40	0.36	0.021	0.635
Liver	2.20^{ba}	2.37^{a}	2.03^{edcb}	2.31^{ba}	2.35^{a}	1.91^{edc}	1.84^{ed}	1.83^{e}	0.142	0.040
Abdominal fat	0.47^{e}	1.11^{a}	0.21^{hg}	0.75^{dcb}	0.16^{h}	0.62^{edc}	0.25^{hgf}	0.58^{ed}	0.085	0.012
Pancreas	0.26	0.25	0.25	0.28	0.19	0.29	0.21	0.24	0.025	0.214
Gizzard	2.08^{a}	1.79^{cb}	1.89^{cba}	1.69^{c}	1.94^{cba}	1.92^{cba}	1.94^{cba}	2.01^{ba}	0.120	0.026
Head	2.77	2.75	2.73	2.53	2.65	2.58	2.53	2.49	0.093	0.750
Legs	4.42^{a}	4.28^{ba}	4.38^{a}	3.96^{dc}	4.05^{dcb}	4.13^{dcba}	4.05^{dcb}	3.92^{d}	0.140	0.048

^{a,b,c,d,e,f,g,h} Mean values in the same row with different superscripts are significantly different. *GOE: Garlic organic extract; SS: streptomycin sulphate.

poorer feed utilization, a greater carcass' fat content, and a big waste of energy compared with male birds of corresponding weight after about 30 days of age (Lesson, 2000).

Conclusion

This study revealed that balanced diets supplemented with garlic organic extract at 40 ppm could serve as replacement for streptomycin sulphate to improve upon production performances of broilers.

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