

Effects of *Xylopia aethiopica* Dried Fruits (Grains of Selim) As Additive on Performance, Carcass Characteristics and Economic Prospects in Finisher Broilers

Isikwenu, J.O and Udomah, J.E.

Department of Animal Science, Delta State University, Asaba Campus, Nigeria.

Abstract: The effect of *Xylopia aethiopica* dried fruits (grains of selim) as additive on performance, carcass characteristics and economic prospects in finisher broilers was investigated. One hundred and ninety five (195) finisher broiler chicks (Arbor acres breed) were randomly allocated to five treatments with each treatment having three replicates in a completely randomized design. Properly blended grains of selim was administered through drinking water on treatments 2, 3, 4 and 5 at concentrations of 0.4, 0.6, 0.8 and 1.0g per litre while chicks on treatment 1 (control) received 0.3g/litre of antibiotics (doxygen). Chicks were fed *ad libitum* with the same isonitrogenous and isocaloric diet containing 20% crude protein and 2905.95 Kcal/kg metabolizable energy for 28 days. Results showed no significant ($P>0.05$) differences among treatments in the final body weight, total weight gain, daily weight gain, total feed intake, daily feed intake and feed conversion ratio. Carcass characteristics and organ weights were similar ($P>0.05$) except in neck weight, heart weight and abdominal fat. There were no significant ($P>0.05$) economic differences in cost of production. Results indicate that grains of selim has growth promoting potentials, gave good carcass indices and generally lower production cost in finisher broilers.

Keywords: antibiotics, carcass, finisher broilers, growth promoter, *Xylopia aethiopica* dried fruits (grains of selim).

I. Introduction

Xylopia aethiopica is a slim, tall, evergreen, aromatic tree growing up to a height of 20m of order Magnoliales and family Annonaceae. It is found in the tropical zones of west, central and southern Africa [1]. The dried fruits of *Xylopia aethiopica* (Grains of Selim) are used as a spice and herbal medicine. The use of antibiotics as growth promoters in poultry production and reports on their residual effects on consumers of poultry products have generated interest in producers trying to do without antibiotics and other drugs [2]. As a result there is need to adopt a more nutrition-based health strategy in future animal production development [2]. This is important because consumers are now paying much more attention to quality and safety of poultry products they eat [3]. [4] reported that grains of selim has antimicrobial and anthelmintic activities and promotes growth in broiler chickens. [5,3] have also reported that some herbs, spices and their extracts stimulate feed intake and endogenous secretions or possess antimicrobial, coccidiostatic or anthelmintic activities. Several herbal products and their extracts have being found to improve broiler performance and resulted in growth-promoting effects [5, 4]. [4] is of the opinion that herbal product could serve as an environmental friendly alternatives to the antibiotic growth promoters. The increasing cost of antibiotics and other drugs in addition to the residual effects of their use has necessitated the need to research into natural herbal plants that could serve as cheap and good alternative to commercial (synthetic) antibiotics. This study is designed to investigate the effect of grains of selim (*Xylopia aethiopica* dried fruits) on performance, carcass characteristics and production cost of finisher broilers.

II. Materials And Methods

2.1 Experimental Site: The experiment was performed at the Poultry Research Unit of the Department of Animal Science, Delta State University, Asaba Campus, Nigeria.

2.2 Experimental Birds and Management: One hundred and ninety five (195) 28 days old finisher broilers (Arbor acres strain) weighing from 1377-1454.67g were used in this study. A deep litter house of fifteen pens with dimensions of 2.04m x 2.03m was used to manage the birds. Feed and water were provided *ad libitum* throughout the period and required vaccinations were administered.

2.3 Experimental Design: The finisher broilers were randomly allocated into five treatment groups with three replicates on equal weight basis in a completely randomized design. Each treatment group had 39 birds and 13 per replicate.

2.4 Experimental Diets: Birds were fed the same isoproteinous and isocaloric diet containing 20% crude protein and 2905.95Kcal/kg metabolizable energy. Properly blended powdered grains of selim was obtained by

pulverizing with mortar and pestle, milling with homogenizer and passed through a standard 2mm sieve to remove all fibre materials. Weights of 0.4, 0.6, 0.8g and 1.0g of grains of selim were dissolved in a litre of water each for more than 10 hours and administered to broilers in treatments 2, 3, 4 and 5 in their drinking water, while broilers in treatment 1 (Control) were given antibiotics (Doxy-gen 20/20 WSP : Doxycycline d' hyclate 200mg and Gentamicine de sulfate 200mg) in their water (0.3g per litre of water). Grains of selim was used to replace antibiotics in the drinking water of finisher broilers in treatments 2, 3, 4 and 5 whenever birds in treatment 1 were given antibiotics. The proximate and phytochemical compositions of *Xylopi aethiopica* dried fruits are presented in Table 1. The composition of the finisher broiler diet is presented in Table 3.

2.5 Measurements: The mean body weight, body weight gain, feed intake and mortality were recorded on replicate basis weekly. Feed conversion which is a ratio of feed consumed and the weight gained over a specific period was also calculated. At the end of eight weeks (56 days), one bird per replicate group, fasted overnight were weighed and sacrificed by cutting the jugular vein for carcass measurements. Organs weighed include heart, liver, pancreas, spleen and gizzard. Economic analysis of finisher broilers was based on the cost of the diet as produced from the prevailing market prices of the ingredients at the time of purchase. This was used to compute the cost of total feed consumed, cost per kg feed, cost per kg weight, the cost differential and relative cost benefit values in relation to the control treatment.

2.6 Chemical Analysis: The proximate compositions of grains of selim and experimental diet were determined according to the procedure of [6] and the phytochemical analysis was carried out by the methods of [7,8].

2.7 Statistical Analysis: All data generated were subjected to one way analysis of variance (ANOVA) for completely randomized design using [9] statistical package and significant differences among the treatment means were separated using Duncan multiple range test [10].

Table 1. Proximate and Phytochemical Compositions of *Xylopi aethiopica* Dried fruits

Parameters %		Phytochemical Test	Results
Dry matter	87.95	Flavonoid	+++
Ash(%)	5.84	Tannin	++++
Crude fibre	10.51	Alkaloid	++
Crude protein	2.73	Steroid	++
Ether extract	9.9	Saponin	+
Nitrogen free extract	58.97	Carbohydrate	+

+ = slightly present, ++= moderately present, +++= present, ++++= strongly present

III. Results

The results of the phytochemical analysis showed that *Xylopi aethiopica* dried fruits contain the following phytochemicals: alkaloids, tannins, flavonoids, steroids, saponin and carbohydrates.

The results of the performance characteristics of the finisher broilers given different concentrations of grains of selim in drinking water are presented in Table 3. There were no significant ($P > 0.05$) differences in final body weight, total weight gain, daily weight gain, total feed intake, daily feed intake and feed conversion ratio in all the treatment groups. However, broiler finishers in treatments given grains of selim were generally better than broilers in treatment 1 given antibiotics in final body weight, total weight gain, daily weight gain and feed conversion ratio.

The results of carcass parameters presented are in Table 4. Result showed that there were no significant ($P > 0.05$) differences in all carcass parameters in the treatment groups except for the neck weight that was significantly ($P < 0.05$) higher in treatment 3 than treatment 4.

The results of organ measurements of broilers given different concentrations of grains of selim in drinking water are presented in Table 5. There were no significant ($P > 0.05$) differences in liver, pancreas, spleen, gizzard and preenticulus weights, and also in colon, small intestine, and caecum lengths, but there was significant ($P > 0.05$) difference in heart weight with treatment 1 significantly ($P < 0.05$) higher than treatments 2 and 4 while all others were similar ($P > 0.05$). There were significant ($P > 0.05$) differences in abdominal fat, with treatment 1 and 3 significantly ($P > 0.05$) higher than treatment 2 but others were all similar ($P > 0.05$). Apart from treatment 3, abdominal fat of broilers given grains of selim were generally lower than those on antibiotic.

The results of the economic analyses of birds given different concentrations of grains of selim in drinking water from 29 – 56 days are presented in Table 6. Results showed that there were no significant ($P > 0.05$) differences in total feed consumed, cost of total feed consumed, cost per kg feed, cost per kg weight, cost differential and relative cost benefit in all the treatment groups

IV. Discussion

The results of the phytochemical analysis showed that grains of selim has alkaloid, flavonoid, tannin, steroid and carbohydrate present in it while saponin is marginally present. [11] have documented that alkaloids possess analgesic, antispasmodic and bactericidal activities. Flavonoids are hydroxylated phenolic substances known to be synthesized by plants in response to microbial infection and they have been found to be antimicrobial substances against wide array of microorganisms *in vitro*, effective antioxidant and anticancerous, and this potential is probably due to their ability to complex with extracellular soluble proteins and bacterial cell walls [12]. They also lower the risk of heart diseases [7]. Tannins binds to proline rich protein and interfere with protein synthesis which make tannin an anti-nutritional substance [12]. Steroids have also been reported to have antibacterial properties and are very important compounds, particularly with their relationship with sex hormones [12]. Saponins are known to produce inhibitory effect on inflammation, hemolytic activity, cholesterol binding properties and bitterness. The identified phytochemical compounds obtained in this study may be the bioactive constituents of this spice. Grains of selim is therefore, proving to be a valuable reservoir of bioactive compounds of substantial medicinal merit [12]. [13, 14, 15, 16] also reported similar findings when they carried out phytochemical screening of *Xylopiya aethiopic*a oil and observed the presence of plant sterols and phenolic compounds such as flavonoids, tannins and the saponins.

Table 2. Composition of Experimental Finisher Broilers Diet

Ingredients	Treatments				
	T1* 0.3g/litre (antibiotic)	T2** 0.4g/litre	T3** 0.6g/litre	T4** 0.8g/litre	T5** 1.0g/litre
Maize	58.00	58.00	58.00	58.00	58.00
Soyabean cake	17.00	17.00	17.00	17.00	17.00
Groundnut cake	9.00	9.00	9.00	9.00	9.00
Fish meal	4.00	4.00	4.00	4.00	4.00
Weath offal	5.00	5.00	5.00	5.00	5.00
Palm oil	1.20	1.20	1.20	1.20	1.20
Bone meal	3.20	3.20	3.20	3.20	3.20
Limestone	1.55	1.55	1.55	1.55	1.55
Salt	0.30	0.30	0.30	0.30	0.30
Premix	0.50	0.50	0.50	0.50	0.50
Methionine	0.15	0.15	0.15	0.15	0.15
Lysine	0.10	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis:					
Crude protein (%)	20.07	20.07	20.07	20.07	20.07
Crude fibre (%)	3.57	3.57	3.57	3.57	3.57
M E Kcal/kg	2905.95	2905.95	2905.95	2905.95	2905.95
Determined analysis:					
Dry matter (%)	87.84	87.84	87.84	87.84	87.84
Ash (%)	9.22	9.22	9.22	9.22	9.22
Crude fibre (%)	11.33	11.33	11.33	11.33	11.33
Crude protein (%)	20.86	20.86	20.86	20.86	20.86
Ether extract (%)	3.09	3.09	3.09	3.09	3.09
Nitrogen free extract (%)	43.34	43.34	43.34	43.34	43.34

Each 2.5kg of finisher vitamin-mineral premix (Bio Organic nutrient systems LTD Nigeria) provided the following vitamins and minerals. Vit A, 8,500,000.00 I.U; Vit D3,1,500,000.00 I.U; Vit E, 10,000.00 I.U; Vit K3,1,500.00mg; Vit B1,1,600.00mg; Vit B2,4000.00mg; Niacin, 20,000.00mg; Pantothenic acid; 5000.00mg; Vit. B6, 1,500.00mg; Vit B12, 10.00mg; Folic acid,500.00mg; Biotin 750.00mg, Choline chloride175,000.00mg, Cobalt 200.00mg; Copper 3,000.00mg;Iodine 1,000.00mg; Iron, 20mg,Manganise,40,000.00; Selenium200.00; Zinc30.000.00; Antioxidant, 1,250.00 *Antibiotics (Doxy-gen 20/20 WSP : Doxycycline d hyclate 200mg and Gentamicine de sulfate 200mg) **Grain of selim. ME: Metabolizable energy.

Table 3. Performance Characteristics of Finisher Broilers Given Different Concentrations of *Xylopi*a *aethi*o*p*i*c*a Dried Fruits (grains of selim) in Drinking Water.

Parameters	Treatments					SEM	SIG
	T1* 0.3g/litre	T2** 0.4g/litre	T3** 0.6g/litre	T4** 0.8g/litr	T5** 1g/litre		
Initial weight (g)	1431.00	1454.67	1421.00	1377.00	1431.33	16.85	NS
Final body weight (g)	3186.00	3274.33	3181.33	3415.33	3394.00	45.12	NS
Total weight gain (g)	1754.00	1867.67	1789.33	2009.33	1891.33	47.72	NS
Daily weight gain (g)	62.64	66.70	63.90	71.76	67.55	170.46	NS
Total feed intake (g)	4786.00	4888.67	4751.67	4727.67	4543.00	76.20	NS
Daily feed intake (g)	170.93	174.60	169.70	168.84	162.25	27.22	NS
Feed conversion ratio	2.74	2.65	2.67	2.34	2.42	0.071	NS

*Antibiotics (Doxy-gen 20/20 WSP : Doxycycline d'hyclate 200mg and Gentamicine de sulfate 200mg)

**Grains of selim

NS: Not significant

Table 4. Carcass Characteristics of Finisher Broilers Given Different Concentrations of *Xylopi*a *aethi*o*p*i*c*a Dried fruits (grains of selim) in Drinking Water.

Parameter	Treatments					SEM	SIG
	T1* 0.3g/litre	T2** 0.4g/litre	T3** 0.6/litre	T4** 0.8/litre	T5** 1g/litre		
Live wt (kg)	3.15	3.1	3.18	3.3	3.47	0.08	NS
Plucked wt (kg)	3.23	2.97	2.97	3.07	3.28	0.07	NS
Dressed wt (kg)	3.03	2.75	2.86	2.81	3.15	0.07	NS
Evisc. Wt (kg)	2.63	2.52	2.55	2.58	2.67	0.06	NS
Head wt (g)	81.92	90.85	58.06	76.95	88.32	5.34	NS
Shank wt (g)	90.44	110.37	96.84	85.68	103.16	4.18	NS
Back wt (g)	630	580	620	550	620	20.00	NS
Drum stick wt (g)	304.63	326.49	337.95	294.79	313.58	11.35	NS
Thigh wt (g)	294.8	330.39	379.01	310.91	393.66	19.47	NS
Wing wt (g)	252.08	259.21	260.95	231.89	277.74	7.23	NS
Neck wt (g)	77.30 ^{ab}	73.88 ^{ab}	93.70 ^a	67.60 ^b	72.98 ^{ab}	3.70	*
Breast wt (g)	920	830	870	950	850	30.00	NS

*Antibiotics (Doxy-gen 20/20 WSP : Doxycycline d'hyclate 200mg and Gentamicine de sulfate 200mg)

**Grains of selima,b,different superscript within the same row are significantly (P>0.05) different, SEM= Standard error of mean, NS= No significant difference.

Table 5. Organ Measurements of Broilers Given Different Concentrations of *Xylopi*a *aethi*o*p*i*c*a Dried Fruits (grains of selim) in Drinking Water

Parameters	Treatments					SEM	SIG
	T1* 0.3g/litre	T2** 0.4g/litre	T3** 0.6g/litre	T4** 0.8g/litre	T5** 1g/litre		
Heart wt (g)	20.71 ^a	13.44 ^b	15.57 ^{ab}	11.30 ^b	17.04 ^{ab}	1.17	*
Liver wt (g)	48.82	44.31	48.04	52.96	69.02	4.72	NS
Pancreas wt (g)	5.20	5.10	6.68	6.72	6.88	0.52	NS
Spleen wt (g)	5.06	3.86	2.58	3.40	3.88	0.49	NS
Gizzard wt (g)	51.48	44.22	43.28	50.73	54.28	1.98	NS
Colon (cm)	21.43	22.17	20.67	21.5	21.83	0.44	NS
Small intestine (cm)	211.10	201.33	205.17	195.10	200.17	5.25	NS
Preventriculus (g)	12.84	9.09	11.3	9.84	9.37	0.76	NS
Caecum (cm)	20.33	20.83	18.17	21.33	19.17	0.70	NS
Abdominal fat (g)	69.23 ^a	12.36 ^b	72.04 ^a	39.44 ^{ab}	51.35 ^{ab}	8.2	*

*Antibiotics (Doxy-gen 20/20 WSP : Doxycycline d'hyclate 200mg and Gentamicine de sulfate 200mg)

**Grains of selima,b: treatment means with different superscript within the same row are significantly (P>0.05) different, SEM= Standard error of mean, NS= Not significant difference.

Table 6. Economic Analysis of Finisher Broilers Given Different Concentrations of *Xylopi*a *aethi*o*p*i*c*a Dried Fruits(grains of selim) in Drinking Water.

Parameters	Treatments					SEM	SIG
	T1* 0.3g/litre	T2** 0.4g/litre	T3** 0.6g/litre	T4** 0.8g/litre	T5** 1g/litre		
Total feed consumed	4.79	4.89	4.75	4.73	4.54	0.08	NS
Cost of total feed consumed (₦)	464.73	469.47	442.87	451.67	434.1	6.84	NS
cost per Kg feed (₦)	97.17	96.33	93.27	95.53	95.57	0.97	NS
cost per Kg weight (₦)	146.87	143.83	139.47	132.37	128.07	3.01	NS
cost differential (₦)	0.00	2.83	7.4	14.5	18.8	2.98	NS
Relative cost benefit (₦)	100.00	102.3	106.23	111.03	115.77	2.41	NS

*Antibiotics (Doxy-gen 20/20 WSP : Doxycycline d'hyclate 200mg and Gentamicine de sulfate 200mg)

**Grains of selim

The similarities in the final body weights, total weight gain, daily weight gain, total feed intake, daily feed intake and feed conversion ratio in Table 3. is an indication that finisher broilers in all treatment groups responded positively in weight performance to the diet and additives supplied. The growth performance pattern in treatment 1 given antibiotic (Doxy-gen 20/20 WSP : Doxycycline d'hyclate 200mg and Gentamicine de sulfate 200mg) and that of other treatments given grains of selim indicate that grains of selim has growth promoting potentials just like antibiotics, therefore grains of selim can be used to replace antibiotics as additive in finisher broiler production. These results are similar to what was reported by [4] who administered different concentrations of grains of selim in drinking water to broiler chicks and obtained improved growth performance just like that of antibiotics growth promoters. [17, 18, 19] who reported that garlic (powder or aqueous extract) as an additive in broiler production produced improved body weight gain, daily feed intake and feed conversion ratio. The result of this study is also in line with the findings of [20, 21, 22, 23, 24] who reported improved body weight gain in broilers when ginger (*Zingiber officinale*, a spice) was used at different rates in feed or drinking water as an additive. When thyme was used as an additive in broiler production by [25, 18, 26, 27, 28, 29], they obtained improved body weight performance and concluded that thyme oil or powder may be a promising alternative to antibiotics growth promoters. The similarities in feed intake and feed conversion ratio which conform to the growth pattern of the birds in this study also agree with the reports of these authors. The improved performance as a result of grains of selim may be attributed to the presence of several compounds in the fruits (Carbohydrates, flavonoids, sterols, saponins, tannins, and alkaloids) which have biological activities such as antioxidant, antimicrobial and pharmacological effects [4]. However the final weight of finisher broiler birds given different concentrations of grains of selim in their drinking water which are treatments 2 to 5 compared to the control treatment indicate that broiler birds can be given all concentrations of grains of selim in drinking water from 0.4g/litre to 1.0g/litre with positive effect on body weight performance.

The carcass characteristics of the treatment groups were all similar because the body weight gains of broiler birds were similar and since carcass is the outcome of body weight development, it agrees with body weight improvement pattern obtained from the treatment groups. Broiler chickens given graded levels of grains of selim performed as good as those on antibiotics in all the carcass parameters measured. Although, the neck weight of treatment 4 was lower than that of treatment 1, 2, 3 and 5, it did not cancel the fact that grains of selim have the same growth promoting capability as antibiotics. The results of this study agree with the antecedent reports of [23, 30, 31,32,33] who obtained improved carcass quality output when broiler birds were given ginger as a feed additive. The organ measurements followed the same pattern as the carcass parameters. However there was significant decrease in abdominal fats in treatments given grains of selim compared to the control apart from treatment 3 which was higher. The general reduction in abdominal fat content of broilers given grains of selim indicate that it has hypocholesteromic activities which may give a better lean meat. There were also significant differences in heart weight but did not affect the fact that grains of selim have growth promoting potentials as antibiotics growth promoters.

Results showed that there were no significant differences in total feed consumed, cost of total feed consumed, cost per kg feed, cost per kg weight, cost differential and relative cost benefit among treatments. However the cost per kg weight were generally lower in treatments given grains of selim than those given antibiotics. The values of the cost differential and relative cost benefit of broilers given grains of selim indicated a general reduction in production cost when compared to those given antibiotics. This is similar to what was reported by [34] who stated that supplementation of dried ginger to broiler diets led to improved performance and reduced feed cost.

V. Conclusion

The similarities of the weight performance, carcass characteristics, organ measurements and production cost of finisher broilers in this study indicated that *Xylopia aethiopica* dried fruits (grains of selim) has growth promoting potentials and can serve as a natural alternative to antibiotics in broiler production. The reduction in abdominal fats indicated that grains of selim has hypocholesteromic properties and may give leaner meat products in broilers. Though not significant, there was general reduction in cost of production in treatments given grains of selim.

Acknowledgement

The authors greatly acknowledge Ogbuefi P. C. Odili and Miss F. Yekini for their help in the laboratory analysis of the proximate, phytochemicals and all related analyses. We also appreciate Delta State University for providing the research farm and other facilities for the work. No funding from any agency was involved in this study.

References

- [1]. C. Orwa, A. Mutua, R. Kindt, R. Jamnadass, A. Simons, Agroforestry Database: a tree reference and selection guide version 4.0, 2009, World Agroforestry Centre, Kenya.
- [2]. M.M. Hossain, Herbs versus drugs: Aspect World Poultry, 2009. Accessed February 14, 2015. Engormix.com/./165/po.htm
- [3]. M. Yegani, T.K. Smith, S. Leeson, H.J. Boermans, Effects of feeding grains naturally contaminated with Fusarium mycotoxins on performance and metabolism of broiler breeders, Poultry Science 85, 2006, 1541-1549.
- [4]. Isikwenu JO. (2014) Xylopia aethiopica dried fruits (Grains of selim) as additive in starter broiler production. Proc. 14th Euro. Poult. Conf. 2014; 578. Stavanger, Norway.
- [5]. A. Karimi, F. Yan, C. Coto, J.H. Park, Y. Min, C. Lu, J.A. Gidden, J.O. Lay, P.W. Waldroup, Effect of level and source of oregano leaf in starter diet for broiler chickens, Journal of Applied Poultry Research, 19 (2), 2010, 137-145.
- [6]. AOAC. Official methods of analysis, 15th edition. Association of Official Analytical Chemists, Washington D. C, 1990.
- [7]. A. Sofowora, Medicinal plants and medicine in Africa, (John Whitley Spectrum Books, Ibadan, Nigeria, 1993).
- [8]. G.E. Trease, W.C. Evans, Textbook of pharmacognosy (Ballere, Tinadl London, 1989).
- [9]. SPSS (Statistical Package for the Social Sciences). 17.0 . SPSS Inc. Chicago, IL, 60606.
- [10]. D.B. Duncan, Multiple range and multiple F-tests, Biometrics. 11, 1955, 1 – 42.
- [11]. R.N. Okigbo, C.L. Anuagasi, J.E. Amadi, U.J. Ukpabi, Potential inhibitory effects of some african tuberous plant extracts on Escherichia coli, Staphylococcus aureus and Candida albicans, International Journal of Integrated Biology 6 (2), 2009, 91-98.
- [12]. R.N.S Yadav, A. Munin, Phytochemical analysis of some medicinal plants, Journal of Phytochemical, 3 (12), 2011, 10-14.
- [13]. H.O. Edeoga, D.E. Okwu, B.O. Mbaebie, Phytochemical constituents of some Nigerian medicinal plants. African Journal of Biotechnology 4 (7), 2005, 685-688.
- [14]. R.S. Kumar, T. Sivakuma, R.S. Sunderem, M. Gupta, K. Muruges, Y. Rajeshwa, M.S. Kumar, K.A. Kumar, Antioxidant and antimicrobial activities of Bauhinia recemosa L. stem bark, Brazilian Journal of Medicine and Biological Research, 38, 2005, 1015-1024.
- [15]. M. Law Plant sterol and stanol margarines and health, British Medical Journal, 320, 2000, 72-83.
- [16]. R.E. Jr. Ostlund, Phytosterols in human nutrition, Annual Reviews in Nutrition, 22, 2002, 533-549.
- [17]. S.B. Aji, K. Ignatius, A.Y. Ado, J.B. Nuhu, A. Abdulkarim, Effects of feeding onion (Allium cepa) and garlic (Allium sativum) on some performance characteristics of broiler chickens, Research Journal of Poultry Science, 4, 2011, 22-27.
- [18]. N.H. Mansoub, Comparison of effects of using thyme and probiotic on performance and serum composition of broiler chickens, Advances in Environmental Biology 5, 2011, 2012 – 2015.
- [19]. M. Pourali, S.A. Mirghelenj, D. Kermanshahi, Effect of garlic powder on productive performance and immune response of broiler chickens challenged with newcastle disease virus, Global Veterinaria, 4, 2010, 616 – 621.
- [20]. A. Tekeli, H.R. Kutlu, L. Celik, Effect of Z. officinale and propolis extracts on the performance, carcass and some blood parameters of broiler chicks, Current Research Poultry Science, 1, 2011, 12 – 23.
- [21]. Herawati, The effect of feeding red ginger as phytobiotic on body weight gain, feed conversion and internal organs condition of broiler, International Journal Poultry Science 9 (10), 2010, 963 – 967.
- [22]. P.N. Onu, Evaluation of two herb spices as feed additives for finisher Broilers, Biotechnology in Animal Husbandry, 26, 2010, 383 – 392.
- [23]. M. Javed, F. Durrani, A. Hafeez, R.U. Khan, I. Ahmad, Effect of aqueous extract of plant mixture on carcass quality of broiler chicks, ARPN Journal Agricultural Biological Science, 4, 2009, 37 – 40.
- [24]. G.O. Farinu, S.G. Ademola, A.O. Ajayi, G.M. Babatunde, Growth, haematological and biochemical studies on garlic and ginger-fed broiler chickens, Moor Journal of Agricultural Research, 5, 2004, 122-128.
- [25]. E.A. Al-Mashhadani, K.A. Farah, Y.M. Farhan, H.E. Al-Mashhadani, Effects of anise, thyme essential oils and their mixture on broiler performance and some on physiological traits, Egyptian Poultry Science 31, 2011, 481-489.
- [26]. M. Toghyani, M. Tohidi, A.I. Gheisari, S.A. Tabeidian, Performance, immunity, serum biochemical and haematological parameters in broiler chick fed dietary thyme as alternative for an antibiotic growth promoter, African Journal of Biotechnology, 9, 2010, 6819 – 6825.
- [27]. G.A.M. Al-Kassie, Influence of two plants extracts derived from thyme and cinnamon on broiler performance, Pakistan Veterinary Journal, 29, 2009, 169-173.
- [28]. S.C. Bolukbasi, M.K. Erhan, A. Ozkan, Effects of dietary thyme oil and vitamin E on growth, lipid oxidation, meat fatty acid composition and serum lipoproteins of broilers, South African Journal Animal Science, 36, 2006, 189 – 196.
- [29]. K. Zhang, Y.F. Yan, C.A. Keen, P.W. Waldroup, Evaluation of microencapsulated essential oils and organic acids in diets for broiler chickens, International Journal Poultry Science, 4, 2005, 612 – 619.
- [30]. G.F. Zhang, Z.B. Yang, Y. Wang, W.R. Yang, S.Z. Jiang, and G.S. Gai, Effects of ginger root (Zingiber officinale) processed to different particle sizes on growth performance, antioxidant status and serum metabolites of broiler chickens, Poultry Science, 88, 2009, 2159-2166.
- [31]. N.H. Mansoub, M.P. Myandoab, The effect of different levels of thyme on performance, carcass traits and blood parameters of broilers, Annals of Biological Research, 2 (4), 2011, 379 – 385.
- [32]. S.S. El-Ghousein, N.A. Al-Beitawi, The effect of feeding of crushed thyme (thymus vulgaris) on growth, blood constituents, gastrointestinal tract and carcass characteristics of broiler chickens, Journal of Poultry Science, 46, 2009, 100-104
- [33]. G.M.J Horton, M.J. Fennell, B.M. Prasad, Effect of dietary garlic (Allium sativum) on performance, carcass composition and blood chemistry changes in broiler chickens, Canadian Journal Animal Science, 71, 1991, 939-942.
- [34]. D. V. Minh, L. V. Huyen, P. Thieu, T. Q. Tuan, N. T. Nga, and N. Q. Khiem, Effect of supplementation of Ginger (Zingiber officinale) and Garlic (Allium sativum) Extracts (Phyto- Antibiotics) on Digestibility and Performance of Broilers Chicken, MEKARN International Conference. Livestock Production, Climate Change and Resource Depletio, 2010, Pakse, Laos.