Effect of garlic and turmeric as additives on growth performance, nutrient digestibility and economics of production of starter broiler chickens

Ehiedu B. N., Ari M. M[1], Yakubu, A.[1]Alhassan I. D[1], Owie P. A.

Department of Animal Science, Faculty of Agriculture, Nasarawa State University, Keffi, P.M.B. 135, Shabu-Lafia, Nasarawa State, Nigeria.

***Corresponding author: berthankiru2016@gmail.com,** +23481620676

Abstract

The ban on the use of antibiotics in the diets of livestock produced for human consumption has created awareness of the consumers and thus triggered need for natural and safe feed additives to achieve better production results from livestock; thus promoting herbal sources (phytogenic extracts) as replacement for antibiotics. The experiment was conducted to evaluate the effect of garlic and turmeric powders as additives on growth performance, nutrient digestibility and economics of production of broiler chickens at starter phase. One hundred and eighty broilers (180) 1-day-old cobb 500 broiler strain chickens were utilized in four treatments diets namely T1, T2, T3, and T4 representing 0, 2.5g turmeric + 2.5g garlic mixture, 2g turmeric- +3g garlic mixture and 3g turmeric-+2g garlic mixture incorporated into 100kg of feed, respectively, in a completely randomized design at starter phase. Feed and water was provided ad libitum, and all customary regular management procedures were followed. Broiler chickens diets were compounded to be iso-caloric and iso-nitrogenous (3000kcal/ME and 23%CP). Additionally, information was acquired about growth performance nutrient digestibility and economics of production. One way analysis of variance was employed by statistical software SPSS to examine the collected data. The results reveal no significant (P>0.05) differences in all growth parameters except in feed intake, protein intake and energy intake which showed significant (P<0.05) differences. Cost of feed consumed and cost per kilogram of weight gain were lower in diet T1, (₦164.94) followed by T4, (₦214 .72) then T2 (₦237 .00) and T3 (₦251 .17). However, birds on T4 diets gave higher revenue (₦986) and gross margin at starter phase (₦391.95). Crude protein digestibility was significantly (P<0.05) but increased in T3 (79.77) than T1 (68.84). It was determined that supplementation of broiler chicken diets with 0.25% garlic and 0.2% turmeric and mixture improved feed intake, protein intake and energy intake also increased digestibility of crude fibre and crude protein in starter phase. It was concluded that supplementing broiler chicken diet at 0.3% turmeric and 0.2% garlic mixture resulted better economics of production with no adverse effects on their performance.

Keywords: Garlic, Growth Performance, Nutrient Digestibility, Economics of production and Broiler Starter

Effet de l'ail et du curcuma en tant qu'additifs sur la performance de croissance, la digestibilité des nutriments et l'économie de production des poussins de chair en phase de démarrage

Résumé

L'interdiction de l'utilisation des antibiotiques dans les régimes alimentaires des animaux destinés à la consommation humaine a sensibilisé les consommateurs et a ainsi déclenché la nécessité d'additifs alimentaires naturels et sûrs pour obtenir de meilleurs résultats de production dans l'élevage ; ce qui a conduit à promouvoir les sources végétales (extraits phytoactifs) comme substitut aux antibiotiques. L'expérience a été menée pour évaluer l'effet des poudres d'ail et de curcuma en tant qu'additifs sur la performance de croissance, la digestibilité des nutriments et l'économie de production des poulets de chair en phase de démarrage. Cent quatre-vingts (180) poussins de chair Cobb 500 âgés d'un jour ont été utilisés dans quatre régimes alimentaires, à savoir T1, T2, T3 et T4 représentant respectivement 0, 2,5g de mélange de curcuma + 2,5g d'ail, 2g de curcuma + 3g d'ail et 3g de curcuma + 2g d'ail incorporés dans 100 kg d'aliment, dans un plan complètement randomisé en phase de démarrage. L'alimentation et l'eau ont été fournies ad libitum, et toutes les procédures de gestion habituelles ont été suivies. Les régimes alimentaires des poulets de chair ont été formulés pour être iso-caloriques et iso-nitrogénés (3000 kcal/ME et 23% de protéines brutes). De plus, des informations ont été recueillies sur la performance de croissance, la

digestibilité des nutriments et l'économie de production. Une analyse de variance à un facteur a été utilisée avec le logiciel statistique SPSS pour examiner les données collectées. Les résultats révèlent aucune différence significative (P>0,05) dans tous les paramètres de croissance, sauf pour la consommation de nourriture, la consommation de protéines et la consommation d'énergie, qui ont montré des différences significatives (P<0,05). Le coût de l'aliment consommé et le coût par kilogramme de gain de poids étaient plus faibles dans le régime T1 (₦164,94), suivi de T4 (₦214,72), puis de T2 (₦237,00) et de T3 (₦251,17). Cependant, les oiseaux ayant reçu les régimes T4 ont généré un revenu plus élevé (?986) et une marge brute plus élevée en phase de démarrage (₦391,95). La digestibilité des protéines brutes était significativement (P<0,05) plus élevée dans T3 (79,77) que dans T1 (68,84). Il a été déterminé que l'ajout de 0,25% d'ail et 0,2% de curcuma dans les régimes alimentaires des poulets de chair a amélioré la consommation de nourriture, la consommation de protéines et la consommation d'énergie, tout en augmentant la digestibilité des fibres brutes et des protéines brutes en phase de démarrage. Il a été conclu que l'ajout de 0,3% de curcuma et 0,2% de mélange d'ail dans les régimes alimentaires des poulets de chair a donné de meilleurs résultats économiques de production, sans effets indésirables sur leur performance.

Mots-clés : Ail, Performance de croissance, Digestibilité des nutriments, Économie de production, Poussins de chair en phase de démarrage

Introduction

Poultry meat production in Nigeria has advantages over other livestock in view of its well-developed value chain (Abdulmojeed *et al*, 2010). It is, however faced with the problems of appropriate feed supply, as its major production constraint, because feed alone constitute over 70% of the total cost of production (Kellems and Church, 2002) and thus, it has consistently been reported as the major determinant of the profitability of the poultry industry in Nigeria and many developing countries (Igboeli, 2000; Esonu *et al.*, 2006, Kwari *et al*., 2012;). This is due to the demand for the same feed resources by humans and animals. Poultry farmers have therefore adopted as part of their cost saving measures the inclusion of additives that could stimulate intake, increase utilization of feed, health and well-being of the animals. Natural plant products have been used as nutraceuticals because of their ability to produce tens of thousands of products as secondary metabolites as a natural defense against disease and infection (Abdel-Wareth *et al.*, 2014; Ari *et al.*, 2021). Many of these natural products have nutritional, pharmacological and biological usefulness that can be of use as supplements and or growth promoters in humans and monogastric animals diets to stimulate improved utilization of nutrients (Abdel-Wareth *et al.*, 2014; Ari *et al.*, 2021) These growth promoters are in the form of chemical products, herbal plants, essential oils, antibiotics, enzymes etc. The ban on the use of antibiotics as growth promoters in the diets of livestock produced for human consumption has created awareness of the consumers and thus triggered the need for natural and safe feed additives to achieve better production results from livestock; thus promoting herbal sources (phytogenic extracts) as replacement for antibiotics (Ortserga *et al.*, 2008).Researchers have used various types of medicinal plants as alternatives to antibiotics in the diet of broilers (Zhang *et al*., 2009). Allicin (diallylthiosulphinate) is one of the active compounds of freshly crushed garlic (*Allium sativum*). Allicin possesses a variety of biological activities such as antimicrobial, anti-inflammatory, antithrombotic, anti-atherosclerotic, serum lipid lowering and anticancer activities (Koch and Lawson, 1996). Allicin is produced by an enzymic reaction when raw garlic is crushed or injured. The enzyme, allicinase, stored in a separate compartment in garlic, combines with a compound called alliin in raw garlic and produces allicin. The antimicrobial mode of action of allicin is thought to be the inhibition of thiol-containing enzymes in the microorganisms. In pursuit of improved chickens healthiness and in order to fulfil consumer expectations in relation to food quality, poultry producers more and more commonly apply natural feeding supplements, mainly herbs (Gardzielewska *et al.*, 2003). Therefore the ban

on the use of antibiotics in poultry has necessitated research on nutraceutical (turmeric and garlic) that could replace these antibiotics while providing the optimum performance and protection of the broilers against diseases

Materials and Methods

Location to the Study

The trial was carried out at Ibas Poultry Farm, No. 117 Ibrahim Bards Street, Keffi, Nasarawa State. The laboratory analysis was done at Department of Animal Science Laboratory Nasarawa State University, Shabu- Lafia Campus.

Sources of experimental feed ingredients and processing

Garlic bulbs were bought from Orange Market, Karu Local Government of Nasarawa State. The bulbs were broken into individual cloves manually before they were sun-dried for three days and ground into powder. Turmeric rhizome were bought from Kaduna State .The rhizome were carefully washed to remove foreign materials and the bad ones were removed then sun-dried for three days and then ground into powder form using electric blender.

Experimental diets

The experimental diets were designed to be isonitrogenous (23% crude protein) and isocaloric (3000kcal/kg ME) for the broiler starter chickens. A total of One hundred and eighty broilers (180) 1-day-old broiler chicks Cobb 500 from Olam Hatcheries, Kaduna State were randomly allocated to the four diets with forty five birds per dietary treatment and three replicates of 15 birds each. All the experimental birds were fed and water *ad* –The feeds were balanced to meet the nutrients requirement of birds as thus presented in Table 1

Table 1. Gross composition of experimental Starter diet (%)

Ingredients (%)	**T1**	**T2**	**T3**	**T4**
Maize	37	37	37	37
Maize bran	10	10	10	10
Soya bean meal	20	20	20	20
Millet	15	15	15	15
Groundnut cake	10	10	10	10
Fish meal	2.5	2.5	2.5	2.5
Bone meal	2.1	2.1	2.1	2.1
Soya oil	1.7	1.7	1.7	1.7
Methionine	0.1	0.1	0.1	0.1
Lysine	0.1	0.1	0.1	0.1
Common salt	0.25	0.25	0.25	0.25
Broiler starter premix	0.25	0.25	0.25	0.25
Limestone	1	1	1	1
Total) (kg)	**100**	**100**	**100**	**100**
Turmeric (g/100 kg)	-	200	250	300
Garlic(g/100 kg)	-	300	250	200
Calculated Analysis				
Energy (kcal/kg, ME)	2834.53	2801.71	2822.98	2803.30
Crude protein (%)	23.25	23.43	23.24	23.15
Calcium (%)	1.22	1.83	1.00	1.81
Phosphorus (%)	0.84	1.13	0.54	0.81

Experimental Design

A completely randomized design was used to conduct the experiment (CRD). A 28-day experiment using eighty (180) broiler chicks of day old birds was carried out to determine the effect of garlic and turmeric as additives on broiler chicken growth performance, nutrient digestibility and economics of production at starter phase. Table 1 shows that four trial diets, designated T1, T2, T3, and T4, were created to

satisfy the birds nutritional needs by substituting different ingredients at T1 0g of garlic and tumeric,T2 200g of turmeric and 300g of garlic, T3 250g of garlic and 250gof turmeric, and T4 200g garlic and 300 g turmeric/100kg diets, respectively.

Data collection

The data collected were feed intake, body weight gain, feed conversion ratio, protein efficiency ratio, energy efficiency ratio, nutrient digestibility. Feed intake was obtained by subtracting the weight of the left over from the weight of the feed given. Body weight gain was obtained by subtracting initial weight from the final weight gained, the feed conversion ratio of the chick was determined by feed intake divided by body weight gain , protein intake was obtained by gain in body weight divided by protein consumed, energy efficiency was obtained by body weight divided by energy consumed and nutrient digestibility was determined by deducting the nutrient in faeces from the nutrient in feed intake divided by nutrient in feed multiplied by 100. Cost of production: The cost of production was estimated as the cost of the chicks and feed consumed throughout the period of the experiment (operational costs such as labour, electricity, and depreciation value of the pen and facilities were not included). Cost of feed per unit weight gain- This was computed as the cost of feed divided by weight gain. Revenue: The revenue was calculated as price of bird multiplied by mean total weight gain per bird. Gross margin: The gross margin was estimated as the difference between revenue and cost of production. Performance index was calculated as the survival % X weight gain/ animals / week (kg) X 100/ FCR

Data Analysis

Data were statistically analyzed using Analysis of Variance (ANOVA) to test the effect of garlic and turmeric as additives on broiler chicken growth performance, nutrient digestibility and economics of production at starter phase. Significant difference was separated using Duncan Multiple Range Test (DMRT).

Results and Discussion

Table 2. Effects of diets supplemented with garlic and turmeric mixture on Growth performance of Broiler starter chickens

Parameters(g)	T1	T2	T3	T4	SEM	LOS
Initial body weight	40.00	40.00	40.00	43.33	0.83	NS
Ave. Daily feed intake	23.57^{b}	33.54^{a}	35.43^{a}	30.09^{ab}	1.68	*
Average weight gain/bird/day	18.57	18.33	18.93	20.48	0.63	NS
Final weight	560.00	553.33	570.00	616.67	18.20	NS
FCR	1.27	1.85	1.90	1.50	0.11	NS
Protein intake (daily)	5.45^{b}	7.76^{a}	8.08^{a}	7.20^{a}	0.38	*
PER	3.50	2.39	2.37	2.88	0.20	NS
Energy intake	74.02^{b}	103.00^{a}	105.12^{a}	86.86^{ab}	4.87	*
EER	0.26	0.18	0.18	0.24	0.02	NS
FE	0.81	0.55	0.54	0.69	0.05	NS
PI	15.00	10.21	10.37	14.40	1.13	NS

ab means on the same row having different superscript differ significantly ($P<0.05$); LOS = level of significance; SEM = Standard error of mean

FCR feed conversion ratio, PER=protein efficiency ratio, EER =energy efficiency ratio FE= feed efficiency PI= performance index

Table 3. Effects of diets supplemented with garlic and turmeric mixture on nutrient digestibility in broiler starter chickens

Parameters (%)	T1	T2	T3	T4	SEM	LOS
Dry matter	62.76	69.14	78.83	73.34	2.36	NS
Crude protein	61.20^{b}	68.84^{ab}	79.77^{a}	73.37^{ab}	2.59	*
Ether extract	61.18	69.16	79.92	72.49	2.61	NS
Crude fibre	43.26^{b}	49.49^{b}	70.09^{a}	36.60^{b}	4.45	*

Nitrogen free extract	66.10	72.00	78.35	69.69	2.09	NS

ab means on the same row having different superscript differ significantly (P<0.05); LOS = level of significance; SEM = Standard error of mean

Table 4: Effect of diets supplemented with turmeric and garlic mixture on economics of production of broiler starter chickens

Parameters (₦)	T1	T2	T3	T4
Cost of feed/kg	249.94	252.39	253.16	254.89
Cost of bird	330.00	330.00	330.00	330.00
Cost of feed consumed	164.94	237.00	251.17	214.72
Cost of feed per kg weight gain	316.50	466.01	481.70	381.14
Total cost of production	544.94	617.01	631.17	594.72
Revenue	896.00	885.33	912.00	986.67
Gross margin	351.06	268.32	280.83	391.95

Discussion

There was significant (P<0.05) increase in protein intake and energy intake of animals fed T2, T3 and T4 diets compared to those on T1. However, feed intake, average weight gain per bird per day, final weight, feed conversion ratio, protein efficiency ratio, energy efficiency ratio, feed efficiency and performance index were not significantly (P>0.05) affected by dietary treatments. The significant increase in feed, protein and energy intakes in T2, and T3 during the starter phase when compared with control group was not in agreement with the earlier report of Durrani *et al*. (2006) who stated that birds fed with turmeric at the level of 0.50% exhibited significantly deceased in feed intake as compared to control group, however the increase could be as result of the combination of garlic and turmeric and processing method.

The non- significant difference showed in daily weight gain, feed efficiency and feed conversion ratio when compared with control was not in agreement with (Demir *et al.,* 2003). Who reported that ginger and garlic as feed additives had encouraging results in regards to weight gain, feed efficiency ratio. However T4 appears to have a better promising value in weight gain, feed efficiency and feed conversion ratio.

Effects of diets supplemented with garlic and turmeric mixture on nutrient digestibility in broiler starter chickens

The effect of diets supplemented with turmeric and garlic mixture on nutrient digestibility by broiler starter chickens was presented in table 3. The results showed a significant (P<0.05) increased in ash digestibility at T3 and T4 which was higher than T1 and T2. Crude protein digestibility was significantly (P<0.05) higher in T3 than T1; however, T2 and T4 were not significantly (P>0.05) different from T1. Digestibility of crude fibre was significantly (P<0.05) increased in (T3) than T1, T2 and T3. There were no significantly (P>0.05) in dry matter ether extract and nitrogen free extract.

The significant increase of crude protein at starter phase is in agreement with Issa and Abo (2012) who reported that dietary garlic powder at the levels of 0.2 or 0.4% dietary inclusion increased crude protein. The resulting increased crude protein and fibre digestibility observed in T3 fed birds at starting is in agreement with the works of Issa *et al.* (2012) who observed significant effects of garlic in nutrient digestibility.

The results in Table 4 shows the effects of diets supplemented with turmeric and garlic mixture on economics of production of broiler starter chickens. The results revealed that Cost of feed per kilogram was higher in birds fed T4(₦254

.89) diet followed by T3 (₦253 .14), T2 (₦252 .39) and T1 (₦249 .94). Cost of feed consumed and cost per kilogram of weight gain were lower in diet T1, (₦164.94) followed by T4, (₦214 .72) then T2 (₦237 .00) and T3 (₦251 .17). However, cost of production, revenue, and gross margin were increased in birds fed T4 (₦391.95) diets compared to others.

The increased revenue and gross margin recorded in when the birds were fed T4 diets in both starting and finishing phases is an indication that supplementing this garlic and turmeric to broilers in this proportion and combination could guarantee return on investment at economic level. In the results recorded for this experiment, addition of turmeric and garlic mixture procured lower diets charge by reducing fee intake. This is in line with Abudabo (2010), who reported that addition of commercial of exogenous enzymes offers potentials to reduce diets commensurate with enhanced production and Anjum *et al*.(2005) who showed that addition of antibiotics in broiler diets improved economic efficiency of broiler chicken.

Conclusion

Based on the results of this study, the following conclusions were made;

Supplementation of broiler chicken diets with 0.25% garlic and 0.2% turmeric and mixture improved feed intake, protein intake and energy intake in starter phase and protein and energy intake in growing phase. Diets supplemented with 0.25% garlic and 0.2% turmeric mixture increased digestibility of crude fibre and crude protein during the starting phase. Mixture of 0.3% turmeric and 0.2% garlic when supplemented in broiler chicken diets resulted to higher economics of producing broiler chickens by ensuring increased in revenue and maintaining the values of gross margin

References

Abdel-Wareth, A. A. A., Hammad, S. and Ahmed, H. 2014. Effects of *Khaya Senegalensis* leaves on performance, carcass traits, haematological and biochemical parameters in rabbits. EXCLI J., 13: 502–512.

Abdulmojeed, Y., Ayoade, J.A. and Dairu, Y.A. 2010. Effect of genotype and population density on growth performance, carcass characteristics and cost-benefits of broiler chickens in north central Nigeria. *Tropical Animal Health Production* 42:719-727

Abudabo, A. 2010. Enzymes supplementation of corn-soybeans meal diets improves performance in broiler chicken. *International Journal of Poultry Science*, 9:292-297.

Anjum, M. L., Khan, A. G., Azim, A. and Afiz, M. 2005. Effect of dietary supplementation of multi-strain probiotic on broiler growth performance. *Pakistan Veterinary Journal*, 25 (1) : 25-29

Belyavin, C. G. 1999. Nutrition management of broiler programs. Pages 93-105 in Recent` Advances in Animal Nutrition. Leicestershire, UK Nottingham University Press.

Demir, E., Sarica, S., Ozcan, M. A. and Suicmez, M. 2003. The Use of natural feed as alternatives for an antibiotic growth promoter in broiler diet. *British Poultry Sci*ence, 44 (Suppl. 1): S44-S45.

Durrani, F. R., Ismail, M., Sultan, A., Suhail, S. M., Chand, N. and Durrani, Z. 2006. Effect of different levels of feed added turmeric (*Curcuma longa*) on the performance of broiler chicks. *Journal of Agricultural and Biological Science.*; 1(2):9-11.

Esonu, B. O., Opara, M. N., Okoli, I. C., Obikaonu, H. O., Udedibie, C. and Iheshiulor, O. O. M. 2006. Physiological responses of laying birds to Neem (*Azadirachta indica*) leaf meal based diets, body weight, organ characteristics and hematology. *Online J. Health Allied Sci*., 2:4-4.

Koch, H. P. and Lawson L .D. 1996. Garlic. The Science and Therapeutic Application of *Allium sativum* l. and Related Species. Williams and Wilkins, New York.

Gardzielewska, J., Pudyszak, K., Majewska, T., Jakubowska, M. and Pomianowski, J. 2003. Effect of plant-supplemented feeding on fresh and frozen storage quality of broiler chicken meat. Animal Husbandry Series of

Electronic *J. Polish Agric. Univ.* 6(2). http://www.ejpau.media pl/series/volume6/issue2/animal/art-12.html

Igboeli, G. (2000). Animal production and agriculture in the new millennium. Proceedings of the 25th Annual Conference, (AC`00), Nigeria Society Animal Production, pp :1-3.

Issa, K. J. and Abo Omar, J. M. 2012. Effect of garlic powder on performance and lipid profile of broilers. *Open Journal of Animal Science*; 2:62-68.

Kellems R. O. and Church, D. C. 2002. Livestock Feeds and Feeding. Fifth Edition. Pearson Educaton Inc., *Upper Saddle River, New Jersey*, 07458. Pp 297-310

Kwari, I. D., Diarra, S. S., Igwebuike, J. U., Nkama, I., Issa, S., Hamaker, B. R., Hancock, J. D., Jauro, M., Seriki, O. A. and Murphy, I. 2012. Replacement Value of Low Tannin Sorghum (Sorghum bicolor) for Maize in Broiler Chickens' Diets in the Semi-Arid Zone of Nigeria. *International Journal of Poultry Science* 11 (5): 333-337.

Ortserga, D. D., Andyar, A. C. and Anthony, T. I. 2008. Growth performance of growing rabbits fed graded levels of garlic (*Allium sativum*). Proc. the 33rd *Annual Conference of the Nigerian Society for Animal Production, Nigeria*, p. 189-191.

Park, S. S., Kim, J. M., Kim, E. J., Kim, H. S., An, B. K. and Kang, C. W. 2012. Effects of dietary turmeric powder on laying performance and egg qualities in laying hens. *Korean Journal of Poultry Science*. 39 (1):27-32.

Zhang, G. F., Yang, Z. B., Wang, Y., Yang, W. R., Jiang, S. Z. & Gai, G. S. 2009. Effects of ginger root *(Zingiber officinale)* processed to different particle sizes on growth performance, antioxidant status and serum metabolites of broiler chickens. *J. Poult. Sci*. 88, 2159-2166

Date received: 31st January, 2024
Date accepted: 4th August, 2024