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Full Length Research

Dietary potency of sun-dried turmeric powder on growth performance, nutrient digestibility and cost analysis of starter broiler chicks

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ABSTRACT: The present study was carried out to assess the dietary potency of sun-dried turmeric (*Curcuma longa*) powder on the performance of the broiler chicks. A total of one hundred and twenty (120) day old *abor acre plus* chicks were randomly allocated to four (4) dietary treatments each with three replicates of ten (10) chicks. Four experimental diets were formulated in such a way that the control diet (T_1) did not contain turmeric powder whereas birds in T_2, T_3 and T_4 fed diets contained 0.20, 0.25 and 0.30% turmeric powder respectively. The feeding trial lasted for 28 days and parameters on growth performance, nutrient digestibility and cost analysis were evaluated. Proximate analysis showed that turmeric powder possesses some nutrients which make it nutritionally viable as a feed additive in the broiler chick diet. There were no significant differences among all the growth performance parameters evaluated across the dietary treatments. Broiler chicks fed 0.30% turmeric recorded numerically best value in terms of body weight and feed conversion ratio compared to other treatments including control. No significant difference was observed in nutrient utilization across the treatment groups. Turmeric powder resulted in efficient feed cost reduction, and among the treatments, the diet with 0.30 % of turmeric powder provides a better economic advantage in terms of feed cost per weight gain. It is concluded that supplementation of turmeric powder up to 0.30% as feed additives in broiler chicks' diet had no negative impact on growth performance, nutrient utilization and production cost of the *abor acre plus* breed of chicks.

Keywords: Cost, feed additives, growth, nutrients digestibility, turmeric.

INTRODUCTION

With a progressive increased human population, an increasing demand for poultry meat is expected in the nearest future. For this reason, poultry health is an important issue. Due to the extremely crowded henhouses and consequently poor management, antibiotics are extensively used to maintain health and activate bird growth (Van Boeckel *et al.,* 2015). This is a major challenge in the poultry industry since according to Landers *et al.* (2012) and WHO (2012), antimicrobial resistance can be derived from the indiscriminate usage of antibiotics, and thus greater regulatory efforts are needed. Moreover, in many countries, there are laws and welfare codes protecting farm animals, including poultry, from distress and fear (Main, 2009; Bonafos *et al.,* 2010). In line with the above requirements, some plant-derived active compounds such, as those present in turmeric, could be used to reduce antibiotic overuse and simultaneously increase animal welfare (Palaniappan and Holley, 2010).

Turmeric (*Curcuma longa* L.) is a popular medicinal herb, which shows a wide range of pharmacological properties, such as antioxidant, antiprotozoa, antimicrobial and anti-inflammatory (Amalraj *et al.,* 2017). Turmeric (*Curcuma longa*) is a tropical plant native to southern Asia which is known as the golden spice of India and has existed for more than 500 years (Plant Cultures, 2005). India is the largest producer of turmeric supplying 94% of

the World's demand (Plant Cultures, 2005). Meanwhile, Nigeria produces an average of 50,000 metric tons of fresh weight turmeric per annum (Ezeagu, 2006). About 10% of the produce is consumed locally as fresh while the remaining 90% is dried for both local consumption and export.

According to the United Nations Food and Agriculture Organization (FAO, 2014), Nigeria was among the countries the global production of turmeric in 2008 was over 1.4 million metric tons (MT) and the major exporting country to US in 2007, this implies that turmeric is readily available in Nigeria.

The use of turmeric in poultry production was formerly reviewed by Khan *et al.* (2012). It contains bioactive secondary metabolites such as curcuminoids and has been successfully used as a suitable feed supplement for poultry. It induces a wide range of positive actions in birds such as improvement of several haematological and biochemical indicators; increase of antibody titers after vaccination (e.g., against Newcastle disease); diminishment of heat stress by different mechanisms; prevention from harmful effects of aflatoxins consumed together with diet; increase of antioxidant activity of several organs (e.g., spleen); decrease some potentially pathogenic bacteria counts, i.e. *Escherichia coli*, in the ileal content of the farmed laying hens (Radwan *et al*., 2008). Although a number of studies have been conducted to evaluate the effect of feeding turmeric rhizome on the performance of broiler chickens, the results have been inconsistent.

Therefore, there is a need for the determination of the optimum level of turmeric powder in the diet of poultry. Improvements in feed efficiency and poultry productivity through dietary incorporation of this natural feed additive would be of tremendous benefit to the animal production industry and the economic well being of the nation.

MATERIALS AND METHODS

Experimental site

The study was conducted at the Poultry House of the Livestock Unit, Teaching and Research Farm, Federal University of Agriculture, Makurdi, Benue State, Nigeria. Makurdi is located between latitude 7°44′N and longitude 8°21′E in the Guinea Savanna Zone of West Africa. The area has an annual rainfall season between 6 to 8 months (March - October) ranging from 508 to 1016 mm with a minimum temperature of 22.8°C and maximum temperature of 40.03°C respectively. The relative humidity ranges between 37.3 and 59.2% (TAC, 2021).

Collection and processing of turmeric

Fresh turmeric was procured from the local market within Makurdi town, Benue State, Nigeria. It was washed with cleaned water to remove adhering soil and chopped into smaller pieces using sharp knives. The chopped turmeric was sun-dried on a flat and clean concrete floor to save moisture content. It was grounded using a hammer mill to obtain turmeric powder. The sample was airtight for subsequent laboratory analysis and feed mixing usage.

Management and disease control

The poultry house and all other equipment were thoroughly washed and disinfected about 10 to 12 days before the arrival of the chicks. The litter material (wood shavings) was mould free and placed in the experimental pen before the arrival of the chicks while the whole house was fumigated to avoid any forms of contamination. The pen was kept warmed about 24 hours before the chicks' arrival in order to maintain a temperature of 85 to 90°F. The brooder temperature was adjusted according to the needs of the chicks and their behaviours. The birds were kept intensively and stocked at 12 birds/m^2. They were fed on formulated experimental starter (0-4 weeks) diets. Feed and water supplied *ad-libitum* throughout the experimental period.

Experimental design and diets formulation

One hundred and twenty (120) day old *Abor acre* plus broiler chicks were obtained from a reputable hatchery in Ibadan Oyo State, Nigeria. The birds were randomly distributed into four dietary groups each having three replicates of ten (10) birds per replicate, housed in deep litter compartments. All the diets were isonitrogenous-isocaloric and formulated to meet standard nutrient requirements of broiler chicks according to NRC (1994) as shown in Table 1.

Growth data collection

Data were collected weekly on feed intake, body weight and weight gain. Feed intake was calculated as the quantity difference of feed given and leftover after 24 hours. Weight gain was determined as the difference in the weight of the birds after 28 days period. Feed: weight gain ratio was calculated as feed intake per weight gain.

Production cost

The cost of feed was calculated from the cost of ingredients used in feed preparation. Feed cost per kilogram live weight gain was calculated from feed cost and feed: gain ratio. Feed cost per weight gain was calculated by multiplying the feed cost per kg by total feed intake divided by total weight gain. Feed cost/chick was calculated by multiplying feed intake per day by the

Table 1. Gross composition of the experimental starter broiler diets.

Ingredients (kg/100kg)	Experimental Diets			
	T1	T2	T3	T4
Yellow maize	53.00	53.00	53.00	53.00
Soya bean meal	30.30	30.25	30.30	30.25
Groundnut cake	4.00	4.00	4.00	4.00
BDG	2.50	2.50	2.50	2.50
Rice bran	2.00	2.00	2.00	2.00
Bone meal	3.00	3.00	3.00	3.00
Blood meal	3.00	3.00	3.00	3.00
Palm oil	1.00	1.00	1.00	1.00
L-Lysine	0.15	0.15	0.15	0.15
Herbo-Methionine	0.20	0.20	0.20	0.20
Vitamin/mineral premix*	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25
Turmeric	0.00	0.20	0.25	0.30
Total	100	100	100	100
Calculated analysis				
ME (Kcal/kg)	2941	2942	2941	2942
Crude protein (%)	23.24	23.22	23.24	23.22
Crude fibre (%)	4.00	4.00	4.00	4.00
Ether extract (%)	4.83	4.84	4.83	4.84
Lysine (%)	1.48	1.48	1.48	1.48
Methionine (%)	0.54	0.54	0.54	0.54
Calcium (%)	1.29	1.29	1.29	1.29
Available Ph (%)	0.71	0.71	0.71	0.71

*To provide the following per kg of diet vitamin A – 15,000.00IU, Vitamin D3 - 3, 000,000IU, Vitamin E- 30,000IU, Vitamin K3,000mg, Vitamin B1 3000,mg Vitamin B2-6000mg, Vitamin B6- 5,000mg, Vitamin B12-40mg, Biotin 200mg, Niacin-40,000mg, Pantothenic acid 15,000mg, Folic acid 2,000mg, choline 300,000mg, Iron 60,000mg, manganese 80,000mg, copper 25,000mg, Zinc 80,000mg cobalt 150mg, Iodine 500mg. (feed formulation was done using the feedwin software application) ME – metabolizable energy; BDG - Brewer dried grain; Ph – Phosphorus.

number of days multiplied by feed cost per kilogram. Operational cost per bird was calculated by adding all other expenses except expenses on feed and broiler chicks. The total cost of production was calculated by adding the cost of day old chick, feed cost per chick and operational cost. Feed cost as a percentage of total production cost was calculated by dividing the cost of feed per kg by the total cost of production multiplied by a hundred.

Nutrient digestibility

Nutrient digestibility evaluation was done at the end of week three (3) and terminated at the end of week four (4). Two birds per replicate group were selected and transferred into metabolic cages. A 3-days acclimatization period was allowed for the birds, and the respective diets were offered to the birds. Daily feed intake and daily faecal output were recorded for 4 days. The droppings were collected per replicate once daily at 8:00 am, weighed and dried in an oven at 70°C to constant weight. Dried excreta were bulked and ground, experimental diets and feacal samples were used to determine their respective proximate constituent according to AOAC (2006), while the metabolizable energy was calculated using the equation; 37 x % CP + 81.1 x % EE + 35.5 x % NFE (Pauzenga, 1985).

Statistical analysis

All generated data were subjected to 2-way Analysis of Variance (ANOVA) using SAS (2008) software package and the means of the parameters which were significantly different ($p<0.05$) were separated using Duncan's Multiple Range Test (DMRT).

RESULT AND DISCUSSION

The result in Table 2 shows that turmeric contains 92.90% dry matter, 7.80% ash, 9.20% crude fibre, 1.32% fats, 15.20% crude protein and 58.00% carbohydrate. This

Table 2. Proximate composition of turmeric powder.

Nutrients	Composition (%)
Dry matter	92.90
Crude protein	15.20
Crude fibre	9.20
Ether extract	1.32
Ash	7.80
Nitrogen free extract	58.00

Table 3. Effect of turmeric powder on growth performance of starter broiler chicks.

Parameter	Experimental diets				SEM	P-value
	T_1	T_2	T_3	T_4		
AIW (g)	39.00	39.00	39.00	39.00	0.00	-
AFW (g)	817.88	799.61	813.41	836.46	17.50	0.93
ADWG (g)	27.82	27.17	27.66	28.48	0.63	0.93
ADFI (g)	46.08	46.20	45.60	46.35	0.93	0.99
FCR	1.69	1.70	1.66	1.63	0.03	0.91

AIW = average initial weight; AFW = average final weight; ADWG = average daily weight gain; ADFI = average daily feed intake; FCR = feed conversion ratio; SEM = standard error of mean; T_1 = Control diet; T_2 = 0.20 % turmeric powder; T_3 = 0.25 % turmeric powder; T_4 = 0.30 % turmeric powder.

implies it could be a good source of carbohydrates. Turmeric 58.00% had higher carbohydrate content than *Acalypha racemosa* (45.26 %) and *Acalypha marginata* (38.24%) (medicinal plants) but Turmeric (15.20% and 7.80%) was lower in crude protein and ash than *Acalypha racemosa*(16.19% and 13.14%) and *Acalypha marginata* (18.15% and 10.32%) respectively (Iniaghe *et al.,* 2009), which implies that *Acalypha racemosa* and *Acalypha marginata* has more mineral content than turmeric because of higher ash content. The 7.80% ash content of turmeric shows that turmeric will contain a reasonable amount of minerals. The fibre (9.20%) present in turmeric will help to add bulk to the feed and prevents the intake of excess starchy food and may therefore guard against metabolic conditions such as hypercholesterdemic (Bamishaiye *et al*., 2011).

The effect of dietary turmeric powder on the growth performance of broiler chicks is presented in Table 3. There were no significant differences among all the parameters evaluated across the dietary treatments group (Guil-Guerrero *et al*., 2017). Broiler chicks fed 0.35% turmeric powder recorded numerically best value in terms of body weight and feed conversion ratio compared to other treatment groups. Non significant effect reported in this study established the findings of Mehala and Moorthy (2008), Ziarlarimi et al. (2009), El-Hakim *et al.* (2009) and Akbarian *et al*. (2012) that did not found significant differences when broilers were fed diets supplemented turmeric. Similarly, El-Deek*et al.* (2002) observed that a diet containing 1 g/kg of ginger did not affect growth performance. Herawati (2010) likewise reported no significant difference in productive performance of broilers fed ginger as a feed additive. Whereas, Rajput *et al.* (2012) showed that supplementation with 0.2g/kg pure curcumin-phytochemicals derived from turmeric increased the body weight gain of broiler chickens. Al-Kassie *et al*. (2011) reported that supplementation of turmeric and cumin mixture in the diets at the rate of 0.5g/kg resulted in a greater body weight gain and lower feed conversation ratio in 42-d old Arbor Acres broiler chickens.

Kumari *et al.* (2007) also reported that turmeric meal supplementation at the rate of 1.0g/kg improved the growth performance of 42-d old Vencob broiler chickens. Non significant differences observed in this study for production performances might suggest the lower inclusion levels of the turmeric powder. Also, it may be attributed to the beneficial properties of phytochemicals in turmeric that possess antimicrobial, antifungal, and antioxidant activities in broiler chicks that may improve the bird utilization of dietary nutrients (Al-Sultan, 2003; Radwan *et al*., 2008).

The effect of dietary turmeric powder on nutrient utilization of broiler chicks is presented in Table 4. There were no significant differences among the means of all parameters evaluated across the dietary treatments. This could be attributed to the stimulation of digestive enzymes by bioactive compounds of turmeric and thus improvement of overall digestion. According to Platel and Srinivasan (2000), phytogenics enhanced the activity of pancreatic lipase, amylase, trypsin and chymotrypsin which enhanced nutrient utilization. Turmeric was found to enhance pancreatic lipase activity, intestinal lipase,

Table 4. Effect of turmeric powder on nutrient digestibility of starter broiler chicks.

Parameter	Experimental diets				SEM	P-value
	T_1	T_2	T_3	T_4		
DM	80.15	78.36	77.87	80.19	0.96	0.81
CP	73.03	74.60	78.57	71.42	1.53	0.44
CF	69.23	71.79	78.02	71.80	1.62	0.28
EE	72.35	72.72	73.21	76.56	1.54	0.81
NFE	68.27	70.57	76.82	69.50	1.72	0.33

DM = Dry Matter; CP = Crude protein; CF = Crude Fibre; EE = Ether Extract; NFE = Nitrogen Free Extract; SEM = standard error of mean; T_1 = Control diet; T_2 = 0.20 % turmeric powder; T_3 = 0.25 % turmeric powder; T_4 = 0.30 % turmeric powder.

Table 5. Production cost of starter broiler chicks fed ietary turmeric powder.

Cost indices	Experimental diets			
	T_1	T2	T_3	T_4
C of DOC (₦/chick)	220.00	220.00	220.00	220.00
FC (₦/kg)	273.00	274.00	275.00	277.00
FC (₦/chick)	357.00	343.35	340.75	349.65
FC/WG (₦/kg)	421.44	429.19	431.34	421.27
OPC (₦/chick)	80.00	80.00	80.00	80.00
TCP (₦/chick)	657.00	643.35	640.75	649.65
CS due to spices (₦/chick)	-	13.75	16.35	7.45
FC (% TCP)	54.35	53.96	53.99	54.00

FC = Starter feed cost; CS = Cost savings; DOC = Day old chicks; C = Cost; TCP = Total cost of production; FC = Feed cost; OPC = Operational cost; T_1 = Control diet; T_2 = 0.20 % turmeric; T_3 = 0.25% turmeric; T_4 = 0.30 % turmeric.

disaccharides, sucrose and maltase activities (Platel and Srinivasan, 1996) which was reported to have a favourable influence on gut function, which is the primary mode of action for growth promoting feed additives (Windisch e*t al*., 2008).

Table 5 showed the effect of turmeric powder on the production cost of starter broiler chicks. The highest amount of feed cost per kg diet recorded for broiler chicks fed diets containing turmeric powder was as a result of the cost of test ingredients. The highest feed cost per chick recorded for birds fed the control diet resulted from the highest feed intake than other dietary groups fed turmeric powder. The highest feed cost per weight gain recorded for T_3 (0.25% turmeric) showed that the birds in the group less efficiently utilized the feed consumed. Efficient feed utilization by the birds in T_4 (0.30%) leads to lesser feed cost per weight gain.

Total production cost was found to be lower in the groups fed turmeric powder relative to control resulting from the higher feeding cost. Cost saving observed across the treatments indicated that turmeric powder is economically beneficial in poultry feed as an additive. Duwa *et al*. (2020) reported that the profits were made on all the birds fed diet containing turmeric powder. The highest feed cost as a percentage of the total cost of production observed for control is attributed to highest feed cost by the group. The result of production cost obtained in this study confirms the report of Gerson *et al.* (2009) who stated that the use of the phytogenic feed additive in broiler chicken diets had an economic advantage when feed cost is considered. Minh *et al.* (2010) also reported that supplementation of dried ginger to broiler diets reduced feed costs.

Conclusion

It is concluded based on the findings of this study that sun-dried turmeric powder possesses some nutrients that make it acceptable to be used as a feed additive in a broiler diet. However, supplementation of turmeric powder up to 0.30% in broiler chicks' diet had no negative impact on growth performance, nutrient utilization and production cost of the *Abor acre plus* breed of chicks. Therefore, supplementation up to 0.30% is recommended.

CONFLICT OF INTEREST

No conflict of interest.

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