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EFFECT OF TURMERIC RHIZOME MEAL AS A NATURAL BIOTECH ADDITIVE IN FINISHER BROILERS' DIETS

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Abstract

In pursuit of sustainable livestock solutions for Nigeria's poultry sector, this study evaluated turmeric rhizome meal (TRM), a phytogenic biotech alternative, as a feed additive for enhancing broiler health and productivity. A 28-day trial assigned 144 Ross 308 broilers to four diets: 0.00% (T_1), 0.30% (T_2), 0.60% (T_3), and 0.90% (T_4) TRM. Performance, haematological, and serum biochemical parameters were analysed. Results indicated that T_3 maximised physiological benefits without compromising growth: body weight gain (2,068g) and feed conversion ratio (2.05) aligned with controls ($p > 0.05$), while blood indices (haemoglobin, lymphocytes) improved significantly ($p < 0.05$). Critically, TRM reduced serum cholesterol (3.66 mmol/L) and enhanced protein metabolism, specifically globulin levels (43.01 g/dL), confirming its role in optimising nutrient utilisation. Turmeric's bioactive compounds (curcuminoids, terpenoids) demonstrate potential as natural biotech tools for replacing synthetic additives and supporting antibiotic-free production. We recommend including 0.60% TRM in finisher broiler diets, a safe, viable strategy to advance livestock value chains in resource-limited settings.

Keywords: Turmeric Rhizome Meal, Broiler Chickens, Biotech Feed Additive, Blood Indices, Sustainable Livestock.

Introduction

Poultry production stands as a critical pillar of food security and economic resilience in Nigeria, providing affordable protein and livelihoods for millions (Olawuyi et al., 2022). Yet, this vital sector faces relentless challenges: devastating disease outbreaks, soaring feed costs, substandard inputs, and unsustainable reliance on synthetic additives that threaten animal welfare and human health (Mnisi et al., 2024). These constraints stifle productivity, inflate mortality rates, and jeopardise the sector's sustainability thus demand urgent innovative solutions.

In pursuit of efficiency, poultry farmers increasingly turn to feed additives. However, conventional synthetic options carry significant risks, including toxic residues in meat, environmental hazards, and antibiotic resistance, a looming crisis for global health (Mnisi et al., 2024). This has ignited a paradigm shift toward natural, phytogenic alternatives that align with one of the health principles. Spices and herbs, with their inherent antimicrobial and therapeutic properties (Rafeeq et al., 2023), offer a promising path forward.

Turmeric (*Curcuma longa*) emerges as a potent option. Beyond its traditional role as a spice, turmeric is rich in curcumin, a bioactive compound celebrated for its anti-inflammatory, antioxidant, and antimicrobial properties (Razavi et al., 2021). Studies suggest that turmeric supplementation can enhance poultry growth, immune response, and meat quality while mitigating disease pressure (Rahmani et al., 2017; Rehman et al., 2025). Crucially, it addresses core industry pain points: it is locally available, cost-effective, and residue-free, key attributes for sustainable scaling in resource-limited settings like Nigeria.

Despite this potential, critical gaps persist. Optimal inclusion levels remain undefined, and physiological impacts on broilers, particularly blood indices and metabolic health, are poorly quantified. Most existing studies use raw or processed forms inconsistently, obscuring practical guidelines for farmers (Qasem et al., 2016; Ogbuewu et al., 2022). This study directly addresses these gaps. We investigated cooked, sun-dried turmeric rhizome meal (TRM) as a standardised, accessible feed additive for finisher broilers. By evaluating its effects on growth performance, haematology, and serum biochemistry, we provide actionable insights to advance biotech-driven, sustainable livestock production, aligning with Agricultural Society of Nigeria 2025's mission to deploy innovative solutions for agricultural resilience.

Materials and Methods

Study Site and Ethical Compliance

The feeding trial was conducted at Geokon's Farm Umuguma, Owerri West, Imo State, Nigeria. The region experiences an annual rainfall of 1,500–2,200 mm, temperatures of 20–27.5°C, and relative humidity of 75–90%. Animal handling protocols followed ethical guidelines for poultry research approved by the Department of Animal Science and Fisheries, Imo State University, Owerri.

Turmeric Rhizome Processing and Experimental Diets

Fresh turmeric rhizomes were sourced from Ose Okwe Odu Market (Onitsha, Anambra State). To mitigate antinutritional factors, 25 kg of rhizomes were washed, cooked in boiling water for 45 minutes, cooled, sliced, and sun-dried for 7 days until crisp. The dried slices were hammer-milled into a fine meal (TRM).A basal finisher diet (Table 1) was formulated using ingredients procured from CEEKINGS Farm Feed Mill (Owerri, Imo State, Nigeria). The diet was divided into four treatments:0.00% (T_1), 0.30% (T_2), 0.60% (T_3), and 0.90% (T_4) TRM.

Table I: Ingredient and Calculated Nutrient Compositions of the Experimental Finisher Broiler Diets

Ingredients	**Treatment Levels of TRM Additive**			
	T_1(0.00%)	**T_2 (0.30%)**	**T_3(0.60%)**	**T_4 (0.90%)**
Maize	50.00	50.00	50.00	50.00
Soya bean Meal	15.00	15.00	15.00	15.00
Fish Meal	4.00	4.00	4.00	4.00
Wheat Offal	12.20	12.20	12.20	12.20
Palm Kernel Cake	10.00	10.00	10.00	10.00
Bone Meal	5.00	5.00	5.00	5.00
Oyster shell	3.00	3.00	3.00	3.00
Common Salt	0.30	0.30	0.30	0.30
Lysine	0.15	0.15	0.15	0.15
Vit. / Mineral premix	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10
Total	100kg	100kg	100kg	100kg

Calculated nutrient compositions of the diets

Crude Protein (%)	17.80	17.84	17.89	17.94
Crude Fibre (%)	4.60	4.62	4.66	4.69
Ether Extract (%)	3.65	3.67	3.69	3.72
Calcium (%)	3.25	3.28	3.32	3.37
Phosphorus (%)	1.11	1.16	1.22	1.29
Lysine (%)	0.42	0.43	0.45	0.46
Methionine (%)	0.26	0.26	0.27	0.27
Metabolizable energy (Kcal/kg)	2692.50	2699.28	2706.15	2713.15

TRM= Turmeric rhizome meal

Note: To provide the following per kilogram of feed: vit A 10,000iu: vit D_3 1,500iu: vit E 2mg: riboflavin 3mg: pantothenic acid 10mg: nicotinic acid 2.5mg: choline 3.5mg: folic acid 1mg: magnesium 56mg: lysine 1mg: iron 20mg: zinc 50mg: cobalt 1.25mg.

Bird Management and Experimental Design

A total of 144 Ross 308 broilers (4 weeks old) were weighed and randomly allotted to four treatment groups (36 birds/group) in a Completely Randomised Design. Each group had three replicates (12 birds/replicate) housed in deep-litter pens. After a 7-day acclimatisation on commercial feed, birds received experimental diets *ad libitum* from weeks 5–9. Clean water, vaccinations, and biosecurity protocols were maintained throughout.

Data Collection

The growth performance metrics, including body weight, feed intake, and feed conversion ratio, were determined.On the final day, blood samples (10 ml/bird) were collected from 2 birds/replicate via brachial vein puncture to determine the haematological and serum biochemical indices. All data were analysed using ANOVA in a CRD framework. Significant means ($p < 0.05$) were separated using Duncan's New Multiple Range Test.

Results and Discussion

Performance Characteristics

Table 2: Performance of the Finisher Broilers Fed Turmeric Rhizome Meal Additive

	Additive Levels of Turmeric Rhizome Meal (%)				
Parameters	**T_1(0.00)**	**T_2(0.30)**	**T_3(0.60)**	**T_4(0.90)**	**SEM**
Mean initial body Wt (g)	1125	1122	1100	1104	5.04
Mean daily Wt gain (g)	75.29^a	76.57^a	73.86^b	70.11^c	0.74
Mean daily feed intake (g)	152.03^b	151.13^b	151.38^b	154.71^a	0.44
Feed conversion ratio (g feed/g wt gain)	2.02^b	1.97^b	2.05^b	2.21^a	0.03
Mortality (%)	-	-	-	-	-

abc; means within same rows with different superscripts are significantly different ($P<0.05$)
SEM = Standard error mean
Wt = weight

Performance data (Table 2) indicated that birds fed the T_2 and T_3diets performed comparably to the T_1 in terms of final body weight, weight gain, and feed intake. Critically, T_2 birds exhibited the best feed conversion ratio (FCR: 1.97), indicating superior efficiency in converting feed to body mass. This suggests that moderate TRM inclusion can support growth without compromising efficiency, a key concern for profitability. The T_4 group delivered an unexpected twist. While they consumed significantly more feed ($p<0.05$), this did not translate into higher weight gain; instead, they had the lowest weight gain and poorest FCR (2.21). This paradoxical result, eating more but growing less efficiently, is likely explained by curcumin's known biological activity. Xie et al. (2019) reported that curcumin intake regulates lipid metabolism in broiler chickens. While potentially beneficial for leaner

carcass, this effect appears to hinder overall weight gain efficiency at the 0.90% level. This highlights the critical importance of dosage optimisation, as excessive inclusion can be counterproductive for growth targets.

Our finding of optimal performance at 0.60% aligns with some studies reporting benefits (Naderi et al., 2014; Choudhury et al., 2018) but contrasts with others showed no effect or detriment at higher levels (Emadi &Kermanshahi, 2007; Obionwu et al., 2017), possibly due to variations in turmeric source, processing, or basal diet

Haematological Profile

Table 3: Haematological Parameters of Finisher Broilers Fed Graded Levels of Turmeric Rhizome Meal

	Additive Levels of Turmeric Rhizome meal (%)				
Parameters	**T_1(0.00)**	**T_2(0.30)**	**T_3(0.60)**	**T_4(0.90)**	**SEM**
Haemoglobin (Hb)g/dl)	10.10	10.20	10.73	10.83	0.26
Packed cell volume (%)	33.33	33.40	33.63	35.87	1.83
Red Blood Cell Count ($X10^6/\mu l$)	3.16	3.20	3.23	3.35	0.09
Mean cell Volume (fl)	35.30	35.77	34.97	33.40	1.23
Mean Cell Haemoglobin (Pg)	42.03	42.67	43.03	42.27	1.36
Mean cell Haemoglobin Concentration (g/dl)	30.83^{b}	31.50^{ab}	31.87^{a}	32.13^{a}	0.33
Erythrocyte Sedimentation rate ($mm^3/1^{st}1hr$)	12.00^{b}	11.67^{b}	12.00^{b}	13.00^{a}	0.27
White blood cell count ($x10^3/\mu l$)	113.00^{a}	105.37^{b}	104.77^{b}	110.77^{a}	1.65
Lymphocytes (%)	84.23^{c}	88.81^{a}	87.37^{ab}	85.00^{bc}	0.98
Monocytes (%)	9.20	9.20	9.96	11.33	0.80
Granulocytes (%)	2.87	2.00	2.67	2.60	0.22

abc means within the same row with different superscripts are significantly different ($p<0.05$)
SEM = Standard Error Mean

The haematological profile (Table 3) indicated that haemoglobin, PCV, RBC, MCV, and MCH showed no variation ($p>0.05$) compared to the control. Importantly, all values fell within the healthy ranges established for broiler chickens (Merck Veterinary Manual, 2012). Notably, birds receiving T_3 and T_4 showed significantly higher MCHC and lymphocyte percentages ($p<0.05$), alongside lower WBC counts in T_2 and T_3.

This pattern robust red blood cell indices, elevated lymphocytes (key immune cells), and potentially reduced overall WBCs suggests TRM may support immune function and reduce subclinical stress or microbial challenges (Naderi et al., 2014). The lower granulocytes in TRM groups further suggest a potential modulation of gut microbiota or an anti-inflammatory effect (Abd El-Ghany, 2024). Crucially, TRM did not induce any adverse blood effects, confirming its safety within the tested range.

Serum Biochemical Indices

Table 4: Serum Biochemical Indices of the Finisher Broiler Chickens

	Additive Levels of Turmeric Rhizome Meal (%)				
Parameters	**T_1(0.00)**	**T_2(0.30)**	**T_3(0.60)**	**T_4(0.90)**	**SEM**
Total protein (g/dl)	63.67^{b}	64.69^{ab}	66.56^{ab}	68.89^{a}	1.66
Albumin (g/dl)	22.20^{b}	22.49^{b}	23.55^{ab}	24.89^{a}	0.47
Globulin (g/dl)	41.47^{b}	42.20^{b}	43.01^{ab}	44.00^{a}	0.50
Urea (mg/dl)	2.73^{b}	3.01^{b}	3.80^{ab}	5.42^{a}	0.70
Creatinine	10.03^{b}	10.10^{b}	11.03^{b}	14.00^{a}	0.52
Cholesterol (mmol/L)	3.87^{a}	3.80^{a}	3.66^{a}	3.20^{b}	0.11
Sodium (mmol/L)	147.00^{b}	150.00^{a}	151.00^{b}	151.00^{a}	0.67
Potassium (mmol/l)	5.45^{a}	5.70^{a}	4.80^{b}	5.30^{a}	0.13
Chloride (mmol/l)	119.00^{b}	123.0^{a}	123.00^{a}	128.00^{a}	2.47

Alkaline phosphatase (iu/l)	11.33	10.70	11.00	12.67	0.67
Aspartate aminotransferase (iu/l)	32.00[b]	33.33[b]	37.67[a]	39.67[a]	1.16
Alanine aminotransferase (iu/l)	10.00[b]	10.33[b]	10.68 [ab]	12.00 [a]	0.51

abc means within the same row with different superscripts are significantly ($p < 0.05$) different.

SEM: Standard error mean.

Serum analysis (Table 4) revealed significant benefits. Birds fed T_3 and T_4 showed significantly increased total protein, albumin, and globulin ($p<0.05$) compared to the control. This indicates that TRM may enhance protein metabolism or utilisation, contributing to better overall physiological status. Furthermore, a highly relevant finding for meat quality and consumer health was the significantly lower serum cholesterol in T_4 birds ($p<0.05$), with a downward trend also observed in T_2 and T_3.

This aligns with turmeric's known role in lipid metabolism (Xieet al., 2019) and suggests TRM inclusion could contribute to producing leaner, lower-cholesterol poultry meat.While urea and creatinine levels increased in T_4, they remained within typical physiological ranges. Liver enzyme markers (Alkaline phosphatase, AST, ALT) were not elevated by TRM supplementation, and values were normal. This is crucial, indicating no liver toxicity at the levels used, although the exact impact on liver enzymes requires further study, given conflicting literature (Nworgu et al., 2003; Emadi & Kermanshahi, 2007).

Conclusion and Recommendations

Cooked, sun-dried turmeric rhizome meal is a safe, natural feed additive that enhances physiological responses in finisher broilers at 0.60% inclusion/100kg feed, optimising growth performance and blood indices without adverse effects. We recommend that poultry farmers adopt this dosage to replace synthetic additives, improving bird health and lean meat production while supporting Nigeria's sustainable poultry sector. Local cultivation and processing of turmeric should be scaled up to ensure cost-effective availability.

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