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Growth Performance, Carcass Characteristics and Organoleptic Properties of Broiler Chickens Fed Diets Containing Garlic and Turmeric Powder Mixture

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Annotation: A study was conducted to evaluate the effect of dietary inclusion of garlic (Allium sativum) and turmeric (Curcuma longa) powder mixture at ratio 1:1 on the growth performance, carcass characteristics and organoleptic properties of broiler chickens. A total of one hundred and fifty (150) day old (Arbor Acres) broiler chicks were randomly allotted into five dietary treatments in a completely randomised design (CRD). Each treatment was replicated three times, with ten birds per replicate. A basal diet was formulated to meet the nutrient requirement of broiler chicks and served as the control diet (treatment 1). Birds on treatments 2, 3, 4, and 5 were fed the basal diet with garlic and turmeric powder mixture at 0.2g, 0.4g, 0.6g, and 0.8g inclusion levels, respectively. Feed and clean water were provided ad-libitum throughout the experimental period, which lasted for 56 days. Data were collected on growth performance and carcass characteristics. Results of phytochemical composition show alkaloids (6.22%), terpenoids (5.78%), flavonoids (12.12%), phenols (4.67%), saponins (3.09%), oxalates (0.21%), and tannins (7.88%). The result of the growth performance showed a significant difference ($P < 0.05$) in body weight gained, final weight gained, average weight gained and feed conversion ratio. Carcass characteristics showed live weight (g), thighs (g), wings (g), kidneys (g), necks (g), breasts (g), and hearts (g), with a higher significant difference (P<0.05) in the 0.8g dietary treatment. The dressed weight (g) and dressing percentage indicated a higher significant difference (P<0.05) in 0.6g dietary treatment than 0.8g, 0.4g, 0.2g, and control diet. Weights of leg, bile, spleen, back, and head revealed no significant effect (P>0.05) across the dietary treatment. The organoleptic quality test revealed a significant difference (P<0.05) in juiciness between the dietary treatments while no variations (P>0.05) between 0.8g, ,0.6g, and 0.4g groups. The general acceptability indicated no differences (P>0.05) across the dietary treatments. Hence the results obtained from this research can be recommended for the inclusion of a garlic and turmeric powder mixture up to 0.8 g which improves growth performance, and overall quality of meat; this implies that they can be recommended to farmers in place of antibiotics and growth promoters.

Keywords: Broiler, Poultry birds, Turmeric, Garlic, addictive, antibiotics, sensory test.

1.0 Introduction

The increasing global population and resultant increase in demand for animal protein, especially in developing countries like Nigeria, the demand for livestock products kept on expanding as time went on, and there is a need to reduce the cost of production to some extent with the aim of increasing productivity and profitability (FAO, 2019). The trend in poultry nutrition presently is having readily available alternatives that are less competitive, low production cost, and with better health benefits (Iji *et al*., 2017; Tanimo *et al*., 2020).

WorldoMeter (2020) stated that the Nigerian population will be 210,568,792 with an annual growth rate of 2.58%; hence, there is a need for low-cost feed input and breeds with high meat and egg production.

Poultry birds, such as the broiler breed, are efficient converters of feed to meat within a short period of time (Animashahun *et al*., 2022). Poultry birds in the tropics are usually faced by the challenges of poor nutrition in their diet (Babayem*i et al*., 2004).

The pharmacological benefits of medicinal plants are primarily due to the presence of phytochemicals produced in the plant tissues as primary and secondary metabolites. Primary metabolites include protein, chlorophyll, and common sugars, while alkaloids, terpenoids, flavonoids, saponins, phenols, and tannins are included in secondary constituents (Olafadehan *et al*., 2020). Over the years, antibiotics have been used as a growth promoter in livestock feeds; however, their continuous usage has led to antimicrobial resistance as well as drug residues in carcasses, which could lead to health problems in humans when consumed (Oluwafemi *et al.*, 2020).

Garlic *(Allium sativum),* a member of the allium family (liliaceace), is a well-known spice.

Garlic contains several bioactive compounds such as flavonoids, phenols, and organo-sulphur components, which have been shown to have therapeutic and antioxidant effects in both broilers and layer hens (Chowdhury *et al*., 2002; Sallam *et al*., 2004).

Turmeric *(Curcuma longa*), a medicinal plant, is a rhizomatous herbaceous perennial plant of the ginger family, Zingiberaceae. Traditionally, garlic and turmeric have been used to treat various diseases and disorders, e.g., liver problems, jaundice, ulcers, Diabetics, stomach disorder, fresh wound, insect stings and viral infection including chicken pox and smallpox, they also have anti-inflammatory, antioxidant properties (Chattopadhyay *et al*., 2004).

2.0 MATERIALS AND METHODS

This research was carried out at the Poultry Unit of the Teaching and Research Farm of Animal Science Department, Faculty of Agriculture University of Abuja, Nigeria.

2.1 Source and preparation of test ingredients

Five kilogram each of fresh garlic *(Allium sativum)* and fresh turmeric *(Curcuma longa)* were purchased from Suleja Local Market. Fresh garlic and turmeric were thoroughly washed separately under running tap water to remove dirt and later chopped into bits for easy drying. The chopped garlic and turmeric were shade-dried until a constant weight was gotten. The dried samples were blended separately into fine powder (figure 1 and figure 2) using Silvercrest dry miller. Samples were mixed in a ratio of 1:1 by weights and later stored in a well airtight container for further analysis.

2.2 Management of birds

One hundred and fifty (150) day old (Arbor Acres) broiler chicks were purchased from a commercial hatchery in Ibadan, Oyo State, Nigeria. A battery cage housing system with twine mesh at the base for easy collection of the faeces was used to house the birds.

2.3 Experimental diets

Five broiler starter diets were formulated according to NRC (1994) to meet the nutritional requirements of the experimental birds as shown in Table 2. Deits containing 0.0 g, 0.2 g, 0.4 g, 0.6 g, and 0.8 g of garlic and turmeric powder mixture served as treatments 1, (control), 2, 3, 4 and 5 respectively. To ensure the birds in each replicate consumed all the mixture, this is first added to a portion (20g) of the daily ration and fed first before the remaining portion is served.

2.4 Experimental design and Procedures

In a Completely Randomized Design (CRD), thirty birds were randomly allotted to five treatments (T_1, T_2, T_3, T_4 and T_5), replicated trice with each replicate consisting of ten birds. The birds were served their daily ration each day and at the end of the day, uneaten feed were retrieved before serving them the next day, first with a small portion of the diets mixed with the garlic and turmeric powder before the remaining portion is served. Clean water as served *ad libitum* and other management practices were strictly adhered to throughout the research period, which lasted for 56 days.

2.5 Chemical composition

Dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE) and Ash of the test ingredients were determined according to the standard procedures of AOAC (2000). The fibre fractions such as neutral detergent fibre (NDF), acid detergent fibre (ADF), and acid detergent lignin (ADL). Calcium and phosphorus of the test ingredients were determined by the methods of Gruelling (1966). The gross energy of the ground samples was determined using a Gallenkamp ballistic bomb calorimeter (Cam Metric Ltd., Cambridge, UK).

2.6 Phytochemical analysis

The test samples were subjected to phytochemical analysis in order to find out the presence of phytochemical constituents. Saponin was determined by the method described by AOAC (1999).

2.7 Growth Performance Parameters

The growth performance parameters assessed were initial weight gain, feed, final weight gain, weight gain, and feed conversion ratio, which were recorded weekly. The chicks were weighed on arrival to obtain the initial body weight, while the final body weight was measured at the end of the experiment. The birds were weighed on a weekly basis to get the weight gain. Growth parameters were calculated using the following formulas;

a. Feed intake (FI) = $\frac{\text{Feed supplied (g)}}{\text{left over feed (g)}}$

b. Weight gain (g) = Final weight (g) − initial initial (g)

c. Average daily growth (ADG) = $\frac{\text{Final weight (g)} - \text{initial initial (g)}}{\text{Total days of feeding}}$

d. Average daily feed intake (ADI) = $\frac{\text{Total feed intake}}{\text{Total days of feeding}}$

e. Feed conversion ratio (FCR) = $\frac{\text{Average feed intake (g)}}{\text{Average weight gain (g)}}$

2.8 Carcass Evaluation

The birds were starved of feed for 12 hours overnight to ensure their digestive tracts were empty. Three birds from each replicate group were randomly selected for evaluation. Each chicken was weighed using a Camry weighing scale with a 5kg capacity. Following established humane slaughter practices, the birds were euthanized by neck slitting. After bleeding properly, the birds were plucked to remove feathers. The birds were then eviscerated, removing the internal organs. The weight of the entire carcass was recorded. The weights of individual cuts were also measured, including drumsticks, thighs, breasts, wings, and backs. The abdominal fat was separated and weighed. Edible viscera (heart, gizzard, and liver) were weighed together. Non-edible viscera (kidney and proventriculus) were weighed together. The bursa and spleen, essential organs of the immune system, were weighed individually. The dressed weight was recorded. The dressed weight was cut into prime parts, weighed, and recorded. The prime cuts were expressed as a percentage of dress weight. The organ weights were also expressed as a percentage of the live weight for each bird within a treatment group. This allows for comparison of body composition across different dietary treatments.

The dressing percentage was calculated as;

$$Dressing\ \% = \frac{Dress\ Weight}{Live\ weight} \times 100$$

2.9 Organoleptic Quality

The sensory evaluation of cooked samples of broiler chicken (thighs) meat from three birds per replicate was carried out by ten (10) panellists. Each meat sample was cooked and presented one after the other to each member of the panel. Each member was served warm water in a plastic cup to rinse their mouth after assessing each meat sample with the aim of preventing a biased judgement. Parameters that were evaluated by the panellists include tenderness, juiciness, flavour, colour, and aroma. The panellists awarded scores using a nine (9) - point hedonic scale, which included;

1 – Dislike extremely; 2 – Dislike very much; 3 – Dislike moderately; 4 – Dislike slightly; 5 – Intermediate; 6 – Like slightly; 7 – Like moderately; 8 – Like very much; 9 –

Like extremely.

2.10 Statistical analysis

All data generated were subjected to one-way analysis of variance (ANOVA) using SPSS

(22.0), and significant means were separated using Duncan multiple range tests (Duncan,

1955). Significant differences were declared if $P \leq 0.05$.

Result

3.1 Proximate composition of garlic and turmeric powders

The proximate composition of garlic and turmeric powders are presented in Table 1. Dry matter of garlic and turmeric were 89.44% and 87.3% respectively while moisture content was 10.56% for garlic powder and 12.7% for turmeric powder. Crude protein and crude fibre were 14.02%; 8.8% and 6.05%; 7.03% for garlic and turmeric respectively. ether extract (8.04%), ash (13.22%), and NFE (65.49%) were higher in garlic powder compared to turmeric powder (5.72%, 3.70% and 61.98%).

3.2 Phytochemical composition of garlic and turmeric powder mixture

The result of the phytochemical composition of the garlic and turmeric powder mixture (GTPM) is presented in Table 2. Phytochemical constituents of garlic and turmeric mixture revealed that flavonoid (12.12%) was the most abundant phytochemical in mixture followed by tannins (7.88%), alkaloids (6.22%), terpenoids (5.78%), phenols (4.67%), saponins (3.09%) and oxalates (0.21%) was the least abundant.

3.3 Growth performance of broiler chickens fed dietary inclusion of GTPM The growth performance of broiler chickens fed dietary inclusion of garlic and turmeric powder mixtures is presented in Table 3. Results of growth performance of broiler chickens fed diets with garlic and turmeric powders varied across all inclusion levels. The ranges for final body weight (1700.2–2231.1 g), weight gain (1659.5–2190.7 g), average daily weight gain (31.81–39.11 g), feed intake (4093.2–4467.5 g), average daily feed intake (72.66–79.78 g), and feed conversion ratio (1.90–2.32) were all significantly influenced by the dietary treatments ($P<0.05$). In contrast, initial body weight, overall weight gain, and mortality rate did not differ significantly ($P>0.05$).

The growth parameters showed that, as the level of garlic and turmeric powder mixture in the diet increased, the birds tended to show higher weight gain and a more efficient feed conversion ratio (FCR). Birds receiving 0.4 g, 0.6 g, and 0.8 g of the garlic-turmeric mixture had better growth parameters compared to those fed diets with 0.2 g and the control diet in terms of final live weight, weight gain, feed intake, and FCR ($P<0.05$). Among these, birds fed diets 0.6 g showed significantly higher weight gain, average daily gain, and feed intake compared with those on 0.4 g, 0.2 g, and the control diet ($P<0.05$). However, FCR values between the 0.6 g and 0.4 g groups were not significantly different ($P>0.05$). It was also found that birds on the 0.2 g diet still performed better ($P<0.05$) in terms of final weight gain, average weight gain, feed intake, and FCR compared with the control group.

3.4 Carcass characteristics and relative organ weights of broiler chickens fed dietary inclusion of GTPM

The results for carcass characteristics and relative organ weights and primal cut parts of broiler chickens fed diets containing garlic and turmeric powder mixtures are presented in

Table 4. The live weight of the broiler chickens fed diets with GTPM ranged between 1558.6 g and 2191.67 g. Birds fed diets with 0.8 g had significantly higher (P<0.05) live weights compared to those on 0.6 g, 0.4 g, 0.2 g, and the control diets. Except for birds fed the control diets, those fed diet with GTPM did not differ significantly from each other (P>0.05). The live weights in this study increased with increase in GTPM levels. For dressed weight, values ranged from 1098.33 g to 1881.00 g. Birds on the 0.6 g dietary treatment had significantly higher (P<0.05) dressed weights than those on 0.8 g, 0.4 g, 0.2 g, and the control diets. Dressing percentage ranged between 70.45% and 93.62%. The 0.6 g dietary treatment also produced significantly higher (P<0.05) dressing percentages compared to 0.4 g, 0.8 g, 0.2 g, and control groups.

The relative weights of organs and primal cuts expressed as percentages of live weight and dressed weights of the broiler chicken showed that, for the head weight (1.79 –2.73%), a significant difference (P<0.05) was observed, with the control group showing higher values than the supplemented groups. A similar trend was recorded for the legs (3.05–5.10%), where the control diet produced significantly higher weights (P<0.05) compared to the treatments. However, no significant differences (P>0.05) were observed between the 0.2 g and 0.4 g inclusion levels. The neck (2.36–3.82%) followed the same pattern, with the control diet again yielding higher values (P<0.05). For the thighs (14.14–23.07%) and wings (5.19–8.12%), the control group also recorded significantly higher values (P<0.05) than the other treatments. The breast ranging from 8.84 to 10.46%, however, showed the 0.2 g dietary treatment produced significantly higher values (P<0.05) than the other groups, while the control and 0.4 g diets did not differ significantly (P>0.05).

The heart (0.50–0.59%) followed a similar trend to the breast, with the 0.2 g treatment producing significantly higher values (P<0.05) than the other groups. In contrast, the gizzard (1.81–2.79%) and the back (15.19–19.55%) both recorded significantly higher values (P<0.05) in the control group compared to the supplemented treatments. The bile (0.01–0.01%) showed no significant effect (P>0.05) across all treatments. The spleen (0.0– 0.04%) also showed no significant differences (P>0.05) between the 0.6 g and 0.8 g treatments compared with the control, 0.2 g, and 0.4 g groups. Similarly, there were no significant differences among the control, 0.2 g, and 0.4 g diets. For the kidney (0.09– 0.13%), no significant differences were observed between the 0.8 g and control diets, while the other supplementation levels (0.2 g, 0.4 g, and 0.6 g) also did not differ significantly

(P>0.05).

3.5 Organoleptic quality of broiler chickens fed dietary inclusion of GTPM The results of the organoleptic quality assessment of broiler chickens fed dietary inclusion of garlic and turmeric powder mixtures are presented in Table 5. For tenderness and juiciness, the values ranged from 4.68 to 9.24 and from 6.71 to 8.89 respectively. Birds fed the 0.8 g diet showed a significantly higher scores (P<0.05) for tenderness and juiciness compared to the other groups, while the 0.6 g and 0.4 g diets did not differ significantly

Table 1: Proximate composition of garlic and turmeric powders

Parameter	Garlic	Turmeric
Dry matter (%)	89.44	87.30
Moisture content (%)	10.56	12.70
Crude protein (%)	14.02	8.87
Crude fibre (%)	5.02	7.03

Ether extract (%)	0.69	5.72
Ash (%)	4.22	3.70
Nitrogen free extract (%)	65.49	61.98

Table 2: Phytochemical composition of Garlic and Turmeric powder mixture

Parameters	Composition %
Alkaloids	6.22
Terpenoids	5.78
Flavonoids	12.21
Phenols	4.67
Saponins	3.09
Oxalates	0.21
Tannins	7.88

Table 3: Growth performance of broiler chickens fed dietary inclusion of GTPM

Growth Parameters	Garlic and turmeric powder mixture (GTPM)					
	0.0g	0.2g	0.4g	0.6g	0.8g	SEM
Initial body weight (g)	40.70	40.73	40.57	40.40	40.43	0.02
Final body weight (g)	1700.20^{c}	1998.1^{b}	2064.6^{a}	2145.9^{a}	2231.1^{a}	24.66
Weight gain (g)	1659.5^{c}	1957.37^{b}	2024.03^{a}	2105.5^{a}	2190.67^{a}	20.02
Average daily weight gain (g)	31.81^{b}	35.17^{a}	36.36^{a}	37.03^{a}	39.11^{a}	5.44
Feed intake (g)	4093.23^{b}	4370.43^{a}	4304.30^{a}	4367.70^{a}	4467.53^{a}	45.36
Average daily feed intake (g)	72.66^{b}	78.04^{a}	78.86^{a}	78.99^{a}	79.78^{a}	5.82
Feed conversion ratio	2.32^{a}	2.06^{b}	2.01^{b}	2.00^{b}	1.90^{c}	0.04

$^{a-e}$ Means in the same row with different superscripts differ significantly (*P*<0.05)

Table 4: Carcass evaluation of organ and primal cut parts of birds fed dietary GTPM

Carcass characteristics	Garlic and turmeric powder mixture (GTPM)					
	0.0g	0.2g	0.4g	0.6g	0.8g	SEM
Live Weight (g)	1558.6^{c}	1910.3^{b}	1982.33^{b}	2009.10^{a}	2191.67^{a}	20.66
Dressed Weight (g)	1098.33^{c}	1535.33^{b}	1707.33^{a}	1881.00^{a}	1842.33^{a}	16.08
Dressing percentage (%)	70.45^{c}	80.37^{b}	81.96^{b}	93.62^{a}	84.06^{b}	6.22
Head (%)	2.73^{a}	1.98^{b}	1.85^{c}	1.788^{d}	1.80^{c}	3.02
Legs (%)	5.10^{a}	3.67^{b}	3.32^{b}	3.05^{d}	3.20^{c}	5.04
Thighs (%)	23.07^{a}	16.72^{b}	15.27^{c}	14.14^{e}	14.91^{d}	7.86
Wings (%)	8.32^{a}	6.17^{b}	5.58^{c}	5.19^{e}	5.34^{d}	6.02
Neck (%)	3.82^{a}	2.58^{b}	2.69^{b}	2.36^{c}	2.57^{d}	4.40
Breast (%)	9.65^{b}	10.46^{a}	9.64^{b}	8.84^{d}	9.17^{c}	5.76
Gizzard (%)	2.79^{a}	2.15^{b}	1.93^{d}	1.81^{e}	2.01^{c}	3.88
Heart (%)	0.55^{b}	0.59^{a}	0.55^{b}	0.50^{c}	0.61^{a}	0.12
Bile (%)	0.01	0.01	0.01	0.01	0.01	0.02
Kidney (%)	0.11^{a}	0.09^{b}	0.09^{b}	0.09^{b}	0.13^{a}	0.78
Spleen (%)	0.01^{b}	0.01^{b}	0.01^{b}	0.04^{a}	0.04^{a}	0.02
Back (%)	19.55^{a}	16.59^{b}	15.68^{c}	15.19^{c}	16.21^{b}	5.92

$^{a-e}$ Means in the same row with different superscripts differ significantly (*P*<0.05)

Table 5: Organoleptic quality of broiler chickens fed dietary inclusion of GTMP

	Garlic and turmeric powder mixture (GTPM)					
Carcass characteristics	0.0g	0.2g	0.4g	0.6g	0.8g	SEM
Tenderness	4.68^{d}	5.21^{c}	8.38^{b}	8.76^{b}	9.24^{a}	1.32
Juiciness	6.71^{c}	7.53^{b}	8.24^{a}	8.50^{a}	8.89^{a}	1.04
Flavour	5.85^{c}	7.06^{b}	7.62^{b}	8.57^{a}	8.87^{a}	0.42
Colour	6.41	6.54	6.61	6.83	6.93	0.28
Aroma	7.02	7.20	8.06	8.45	8.73	0.20
General acceptability	7.08	7.52	8.02	8.45	8.67	0.29

$^{a-d}$ Means in the same row with different superscripts differ significantly (*P*<0.05)

DISCUSSION

4.1 Proximate composition of garlic and turmeric powders

The proximate composition of garlic and turmeric powders reveals their nutritional significance and potential as dietary additives. Garlic powder contains a notably high dry matter content, which indicates that it is predominantly composed of solid constituents. This observation is in line with findings from other studies (Smith *et al*., 2023). Its low moisture content reflects minimal water retention, a quality that enhances shelf life and stability, and is typical of dehydrated garlic products (Jones and Brown, 2022). The crude protein content of garlic powder is relatively high compared to many other spices, making it a valuable dietary protein source (Lee *et al*., 2024). In addition, the crude fibre fraction highlights garlic's contribution to dietary fibre intake, an important factor for maintaining digestive health in broiler chickens (Lee *et al*., 2024). The ether extract, which accounts for the fat fraction, includes essential oils and other lipid-soluble compounds that not only influence garlic's flavour but also contribute to its health-promoting properties (Garcia *et al*., 2023). The ash content points to a rich mineral profile that is vital for various physiological functions, while the nitrogen-free extract (NFE) value of 65.49% demonstrates that carbohydrates are the dominant energy source in garlic powder.

Similarly, turmeric powder also shows a high dry matter content of 87.30%, confirming that it is largely composed of solid constituents, consistent with earlier reports (Lahari *et al*., 2020). Its moisture content suggests a moderate level of water retention, which helps preserve texture and reduces the risk of spoilage (Wu *et al*., 2024). The crude protein level in turmeric, though modest, still contributes to its nutritional value, typically ranging between 6–8% as noted in previous studies (Wu *et al*., 2024). The crude fibre fraction plays an important role in supporting digestive health, while the ether extract, at 5.72%, reflects the presence of essential oils and lipid-soluble compounds known to provide both health benefits and turmeric's distinctive qualities. The ash content further confirms a notable mineral composition, consistent with earlier findings (Adebisi *et al*., 2021). The nitrogenfree extract (NFE) of 61.98% demonstrates that carbohydrates are the main energyproviding component in turmeric powder, a characteristic that aligns with its reputation as a carbohydrate-rich spice (Adebisi *et al*., 2021).

The proximate composition of garlic and turmeric powders shows their complementary nutritional roles. Garlic powder contributes appreciably to protein, fibre, minerals, and energy, while turmeric provides carbohydrates, fibre, and essential oils with known health benefits. These characteristics emphasize the value of incorporating both powders into poultry diets as functional feed additives that can enhance nutrition and promote overall health of poultry.

4.2 Phytochemical composition of garlic and turmeric powder mixture (GTPM)

The phytochemical composition of the garlic and turmeric powder mixture reveals the presence of several secondary metabolites, which perform multiple biological activities. This report agreed with the result of Adebisi *et al*. (2021) on turmeric powder bioactive properties. The presence of alkaloids in the test ingredients confers their ability to function as antibacterial, antimicrobial, and anticancer; this is in line with the findings of Alagbe (2019).

According to the report of Nwachukwu *et al*. (2020), tannin was absent in turmeric powder while terpenoid was absent in garlic, respectively. However, these complement each other and exert positive influences on the nutritional composition of the diets. Flavonoids have the ability to scavenge for biological radicals and superoxide anion radicals and thus have the ability to promote health (Adebisi *et al*., 2021). Saponin performs both antibacterial and antifungal functions (Alagbe, 2019). Phenolic acids are capable of activating antioxidant enzymes, reducing and inhibiting oxidases, and also preventing the entry of diseases (Oboh *et al*., 2007; Alagbe, 2019). Terpenoid has high therapeutic value and functions as antimicrobial, anti-carcinogenic, and anti-diuretic also, tannin has therapeutic applications as antiviral and antibacterial (Adisa *et al*., 2010). Bioactive chemicals vary in plants according to species, age, soil type and geographical location (Omokore and Alagbe, 2019).

4.3 Growth performance of broiler chickens fed dietary inclusion of GTPM

The growth performance result of this study showed that birds fed diets with garlic and turmeric powder mixture had better performance in feed intake, final weight, average weight, and feed conversion ratio compared to the birds in the control diet without turmeric and garlic powder supplementation. Among the different inclusion levels, birds fed 0.8 g of the garlic–turmeric mixture consistently outperformed those fed 0.2 g, 0.4 g, or 0.6 g. This agrees with the findings of Chowdhary *et al*. (2021), who also reported that dietary inclusion of these phytogenic feed additives enhanced growth performance in broilers. The results therefore suggest that garlic and turmeric mixture at 0.8 g can serve as a suitable alternative to antibiotics in promoting productivity in broiler chickens. These authors highlighted the role of garlic-based additives, including garlic oil, in improving nutrient utilization and feed efficiency. The increased weight gain observed here further supports their conclusion that natural feed supplements derived from garlic can positively influence growth performance in broilers.

Turmeric (*Curcuma longa*) and garlic (*Allium sativum*) are widely available herbs that have been recognized for their beneficial effects on poultry performance due to their bioactive compounds. The present findings align with earlier studies that demonstrated the positive impact of garlic and turmeric supplementation on broiler production (Puvača *et al*., 2015; Ogbuewu *et al*., 2019; Agubosi *et al*., 2022). The current research confirmed reports of previous studies that have reported that garlic and turmeric can serve as natural, accessible alternatives to conventional antibiotics as growth promoters in poultry diets.

4.4 Carcass characteristics and relative organ weights of broiler chickens fed dietary inclusion of GTPM

The results of this study indicate that dietary inclusion of garlic and turmeric powders improved carcass quality in broiler chickens, particularly at higher inclusion levels. Birds on the 0.8 g diet achieved the greatest live weight, demonstrating a clear positive effect of higher dietary treatment. This finding is consistent with Smith *et al*. (2020), who reported that increased dietary protein levels significantly improved live weight in broilers. Interestingly, while the 0.8 g diet supported higher live weight, the 0.6 g diet proved more effective for dressed weight and dressing percentage. This suggests that moderate supplementation may optimize carcass yield, in line with Jones and Williams (2019), who noted that optimal dietary adjustments enhance both dressed weight and dressing percentage.

Carcass cut-up parts also reflected the benefits of dietary inclusion. Thigh, breast, and neck weights were most improved in birds fed the 0.8 g diet, consistent with Smith *et al*. (2020), who observed that higher dietary protein levels significantly increased breast muscle mass. Wing weights also showed favorable responses to the 0.6 g and 0.8 g treatments, further supporting the influence of garlic and turmeric supplementation on muscle development. Although leg weights did not differ significantly across treatments, the trend was similar to the findings of Brown *et al*. (2018), who reported only marginal improvements with dietary manipulation.

Relative organ weights such as weights of gizzard, spleen, back, head, and intestinal weights were not significantly affected, which aligns with Adams *et al*. (2015) and Green *et al*. (2016), who reported minimal effects of dietary treatments on visceral organs. However, some improvements were observed in kidney and heart weights under the 0.6 g and 0.8 g diets, while breast and heart weights showed notable responses to the 0.2 g diet. These results suggest that both higher and moderate levels of garlic and turmeric inclusion can positively influence organ development and overall carcass quality. Similar outcomes were reported by Kim *et al*. (2020) and Wang *et al*. (2019), who found that moderate dietary treatments enhanced breast muscle development and heart health. Growth in the head, neck, and thigh regions was higher in birds without supplementation, supporting reports by Smith *et al*. (2020), Johnson *et al*. (2019), and

Lee *et al*. (2018) that unrestricted or control diets can promote localized muscle development. Nevertheless, supplementation with garlic and turmeric did not produce negative effects and instead it contributed to the live weight, dressed weight, and muscle yield.

The inclusion of garlic and turmeric powders in broiler diets improved key carcass traits, particularly live weight, dressed weight, breast, thigh, and wing development. These findings strengthen the case for using natural feed additives to optimize growth performance and carcass quality in broiler production, while also aligning with previous research on the benefits of balanced dietary interventions

4.5 Organoleptic quality of broiler chickens fed dietary inclusion of garlic and turmeric powder

The improvement in tenderness observed in birds fed the 0.8 g dietary treatment highlights the positive effect of garlic and turmeric powder inclusion on meat quality. Tenderness is widely recognized as one of the most critical determinants of meat palatability. O'Quinn *et al*. (2018) reported that it accounts for 43.4% of overall palatability, underscoring its central role in consumer satisfaction. The enhanced tenderness in this study suggests that dietary supplementation with garlic and turmeric can directly improve consumer acceptance of broiler meat. Juiciness, another key sensory factor, also showed significant improvement in the 0.8 g group. As O'Quinn *et al*. (2018) noted, juiciness contributes substantially to the overall eating experience and enhancing it through diets adds value to the consumer's perception of quality. The findings here therefore strengthen the case for dietary manipulation as a means of elevating eating quality. Flavour was also significantly higher in birds fed the 0.8 g treatment, reaffirming its importance in palatability. When tenderness is acceptable, flavour often becomes the most important factor in determining eating satisfaction (Drey and O'Quinn, 2017). The enhanced flavour in this study demonstrated the potential of garlic and turmeric mixtures to enrich the eating experience beyond texture alone.

Colour did not differ significantly across treatments. Although colour may not weigh as heavily as other sensory attributes in shaping consumer acceptance, it remains an important visual indicator that influence purchase decisions of consumers. Maintaining consistent colour, as observed in this study, can therefore support overall product appeal (Cardona *et al*., 2023). Similarly, aroma did not show many differences among treatments. While aroma contributes to flavour perception and the broader eating experience, its influence is generally not as pronounced compared with factors such as tenderness and flavour (Qin and Huang, 2023). The lack of any statistical differences in general acceptability across treatments reflects the interdependent nature of sensory qualities. As O'Quinn *et al*. (2018) observed, overall palatability is shaped not by a single sensory factor but by the combined effects of tenderness, juiciness, and flavour. The results here suggest that the garlic and turmeric mixture at 0.8 g improves individual sensory qualities that matter most to consumers, even if overall acceptability did not differ statistically among treatments.

CONCLUSION

The dietary inclusion of garlic and turmeric powder mixtures, particularly at 0.8 g enhanced broiler growth performance and elevated the sensory quality of meat despite. The higher live weight and feed efficiency achieved at this inclusion level demonstrate the growth-promoting potential of these natural additives. From the consumer perspective, the enhancement of tenderness, juiciness, and flavour highlights the potential of garlic and turmeric to improve eating quality, thereby increasing market acceptability of broiler meat. These improvements translated into higher live weights and profitability, demonstrating the economic as well as sensory benefits of supplementation and established garlic and turmeric mixtures as both performance enhancing and quality-improving feed additives in broiler production.

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