

Carcass Characteristics and Sensory Appraisal of Broiler Chickens Fed Varying Levels of Cinnamon Powder

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Abstract

This study investigated the effects of cinnamon powder (CP) supplementation on carcass characteristics and sensory qualities of broiler chickens. A total of 150-day-old Ross 308 chicks were randomly assigned, after weight balancing, into five treatments in a completely randomized design, each with three replicates of ten birds. The treatments included: T1 (control, 0.00g CP), T2 (0.10g CP + 4L water), T3 (0.20g CP + 4L water), T4 (0.30g CP + 4L water), and T5 (0.40g CP + 4L water). Data were analyzed using one-way ANOVA, and means separated with Duncan's Multiple Range Test. Results showed that broilers in T3 recorded the highest live weight (730.16g) and slaughter weight, while T2 and T5 recorded the lowest values. Organ weights, including liver, lungs, kidney, proventriculus, and abdominal fat, were significantly ($p < 0.05$) affected by dietary treatments. The heaviest liver was observed in T3, while the control group had the lowest. Sensory evaluation revealed that flavour, juiciness, tenderness, and overall acceptability were significantly ($p < 0.05$) improved with cinnamon inclusion, with T3 outperforming other treatments. It is concluded that supplementing broiler diets with 0.20g cinnamon powder per 4 litres of water enhances carcass yield and sensory quality, particularly at 3 and 6 weeks. The consistent performance of T3 birds suggests that moderate cinnamon inclusion is optimal for growth and meat quality improvement. It was recommended that the inclusion of 0.20g cinnamon powder per 4 litres of water is recommended for broiler production to promote better carcass characteristics and consumer acceptability.

Keywords: Carcass Characteristics, Sensory appraisal, broiler chickens, cinnamon powder, Poultry nutrition.

Introduction

Poultry remains the fastest-growing branch of agriculture, providing a major source of meat and eggs globally. Millions of people depend on this sector for their livelihoods (Kabir *et al.*, 2016) while also strengthening the global economy (Hamid *et al.*, 2016). Within poultry enterprises, broiler production is particularly prominent due to its short production cycle and quick financial returns (Kim *et al.* 2020). In recent years, contract broiler farming has

been introduced, ensuring farmers fair product prices under agreements with feed companies (Saha *et al.*, 2021). Broiler farming is now practiced nationwide, gaining significant market share and expanding rapidly. In Nigeria, broiler chicken production plays a pivotal role in the agricultural sector, meeting the increasing protein demands of a rapidly growing and increasingly urbanized population (National Bureau of Statistics, 2023). According to FAOSTAT (2017), this growth is linked to the increased number of broilers raised, while FAO (2022) reports that Nigeria ranks as the second-largest poultry producer in Africa, with approximately 180 million birds annually (70% broilers and 30% layers). Poultry meat production in Nigeria rose from 158,000 tons in 2000 to 317,000 tons in 2015 and is projected to reach 544,000 tons by 2030 (FAO, 2022). The rising demand for broiler products, coupled with the availability of exotic breeds and the simplicity of rearing techniques, has elevated broiler farming from subsistence to a commercial agribusiness (Ebukiba and Luka, 2019). Beyond increasing household income, the industry also creates opportunities for small-scale and emerging players in the value chain (FAOSTAT, 2017). Importantly, broiler production provides the fastest turnover and highest return on investment in livestock enterprises (Haruna *et al.*, 2020). Despite its profitability, broiler farming faces several risks and challenges (Adedeji *et al.*, 2014a; Benjamin *et al.*, 2024). Poor planning and management often undermine farm biosecurity, while disease outbreaks may persist despite routine vaccination and medication, leading to losses (Adedeji *et al.*, 2014b; Benjamin *et al.*, 2024). Additionally, natural disasters and climatic factors can negatively impact productivity and profitability.

Poultry meat and eggs are vital sources of high-quality protein, minerals, and vitamins essential for a balanced human diet (Madhu *et al.*, 2019). For decades, antibiotics have been incorporated into poultry feed to improve health, reduce mortality, and enhance productivity. While effective against infections, their use poses a public health risk by fostering antimicrobial resistance (Mahasneh *et al.*, 2024). In response, interest has grown in plant-based alternatives as feed additives, which are safe, natural, and residue-free (Qaid *et al.*, 2024). Globally, about 80% of the population relies on herbal remedies for disease management, often viewed as affordable as and less harmful than conventional medicine. Many plants contain bioactive compounds beneficial to poultry health (Rama-Rao *et al.*, 2019), with herbs generally considered safe for both humans and animals.

Among phytogetic feed additives, cinnamon (*Cinnamomum verum*) has received considerable attention. Widely used as a spice in human diets, cinnamon contains cinnamaldehyde and other phenolic compounds with strong antioxidant, antimicrobial, anti-inflammatory, and anti-proliferative properties (Ali *et al.*, 2021; Alizadeh-Behbahani *et al.*, 2020). Its medicinal potential extends to managing serious conditions such as Alzheimer's, Parkinson's, and diabetes. In poultry nutrition, cinnamon has shown promise as a natural growth promoter and antibiotic alternative, improving feed intake, growth performance, and feed conversion efficiency (Cristo *et al.*, 2022). Furthermore, it aids

digestion, enhances appetite, combats pathogens, reduces oxidative stress, and alleviates inflammation and acid reflux (Qaid *et al.* 2022; Ding *et al.* 2022).

Carcass characteristics, such as muscle, fat, and bone proportions are critical indicators in broiler production (Mir *et al.*, 2017). Traits like carcass weight, breast and drumstick yield are not only important for marketing but also influence profitability through growth performance and feed conversion efficiency (da Silva *et al.*, 2017). While consumers focus on sensory attributes such as tenderness, color, juiciness, and flavor, producers emphasize carcass weight and fat distribution, which determine revenue (Amao *et al.*, 2024). Both physical qualities (e.g., muscle yield, water retention, cooking loss) and sensory properties (e.g., texture, color, taste) are influenced by growth rate and body composition (Raluca-Aniela *et al.* 2024; Jung *et al.*, 2024). Consumers expect tenderness; therefore, measuring tenderness is an appropriate way of measuring consumer satisfaction in eating meat products, and it is subjectively judged to be a sense of the hardness or elasticity of tough or tender meat (Zdanowska-Sasiadek *et al.*, 2019) while texture is a constructive technique that mimics the bite action of the mouth through a popular double compression test to determine the textural properties of foods, and it does not require a large number of investigators to assess the texture of poultry meat (Amao and Ogunjinmi, 2023) and consumer preferences vary across regions and cultures. This study aims to assess the impact of different inclusion levels of cinnamon powder on broiler carcass traits and sensory qualities.

Problem Statement

The rising demand for high-quality poultry meat has necessitated the exploration of natural feed additives that can enhance growth performance, carcass yield, and meat quality while maintaining consumer safety. Conventional synthetic growth promoters, though effective, pose health risks and face increasing restrictions due to their residual effects in meat. Cinnamon (*Cinnamomum* spp.), a natural spice with antioxidant, antimicrobial, and digestive-enhancing properties, has gained attention as a potential alternative. However, information on its optimal inclusion level for improving carcass traits and sensory qualities in broilers remains limited and inconsistent. Determining the appropriate dietary supplementation of cinnamon powder is therefore essential to maximize carcass yield, improve meat acceptability, and promote safer poultry production. The broad objective is to evaluate the effects of varying levels of cinnamon powder on carcass characteristics and sensory appraisal of broiler chickens specifically:

1. To determine the effect of different inclusion levels of cinnamon powder on live weight, slaughter weight, and carcass parameters of broiler chickens at 3 and 6 weeks respectively
2. To assess the influence of cinnamon powder supplementation on edible internal organs (liver, lungs, kidney, proventriculus, and abdominal fat) of broiler chickens at 3 and 6 weeks respectively

3. To evaluate the sensory attributes (flavour, juiciness, tenderness, and overall acceptability) of broiler meat fed varying levels of cinnamon powder of broiler chickens at 3 and 6 weeks respectively.
4. To identify the optimum level of cinnamon powder inclusion that maximizes carcass yield and consumer acceptability of broiler chickens at 3 and 6 weeks respectively.

Materials and Methods

Experimental Site

The study was carried out at the Poultry Unit of the Teaching and Research Farm, Ladoké Akintola University of Technology, Ogbomoso, Oyo State, Nigeria. Ogbomoso is a derived savanna zone of Nigeria that lies within the latitude 8° 15'N and longitude 4°15'E. The location lies at an elevation of 300 - 600 meters above sea level, with an average annual rainfall of 1247mm and mean temperature of 27 °C (GoogleMap, 2025).

Source and Preparation of Test Ingredient

Cinnamon powder was imported from the United States of America and produced by Gel Spice Co. INC., Bayonne, NJ07002, USA.

Experimental Diets

From day-old to the third week, the chicks were fed a commercial chick crumble diet containing 22% crude protein and 3000 kcal/kg metabolizable energy, followed by a finisher mash diet (18% crude protein and 3150 kcal/kg metabolizable energy) from the fourth to the sixth week. Feed and water were provided ad libitum throughout.

Formulation of Experimental Treatments

Different concentrations of cinnamon (*Cinnamomum zeylanicum*) powder (CP) were dissolved in 4 liters of water for the treatments as follows:

- T1: 0.00 g CP
- T2: 0.10 g CP + 4 L water
- T3: 0.20 g CP + 4 L water
- T4: 0.30 g CP + 4 L water
- T5: 0.40 g CP + 4 L water

Experimental Animals and Management

A total of 300-day-old Ross 308 broiler chicks were obtained from a reputable hatchery in Ibadan, Oyo State. Initial body weights were recorded, and the chicks were randomly allotted into five dietary treatments, each with three replicates of 20 birds, following a Completely Randomized Design (CRD). The birds were raised under intensive management in a deep litter housing system with wood shavings as bedding. Feed and water were

supplied ad libitum daily. Standard vaccination and medication protocols were administered to maintain flock health.

Data Collection

Carcass Characteristics

At weeks 3 and 6, sixty birds (four per replicate) were randomly selected, fasted for 12 hours to empty their crops, and then slaughtered. Following complete blood drainage, birds were defeathered, eviscerated, and weighed. Measurements included defeathered weight, carcass weight (after removing head and shanks), and weights of primal cuts (breast, thigh, drumstick, and back). These were expressed as percentages of live weight using the formula:

Relative weight of primal cut = weight of cut / live weight *100

Sensory Evaluation

Meat quality was assessed using a 10-member sensory panel. Thigh meat samples were cooked for 10 minutes without salt, cooled to room temperature, and served to panelists. A nine-point hedonic scale was used to evaluate color, tenderness, flavor, juiciness, and overall acceptability following Amao *et al.* (2024).

Statistical Analysis

All data were analyzed using one-way Analysis of Variance (ANOVA) in SAS (2009). Significant differences among means were separated using Duncan’s Multiple Range Test (DMRT).

Results

Table 1 presents the effects of cinnamon powder on carcass traits of broiler chickens at 3 weeks of age. All measured parameters were significantly ($p<0.05$) affected by the dietary treatments. Broilers fed diet T₃ (0.20g CP + 4 L of water) recorded the highest live weight (730.16 g), while the lowest live weight (580.45 g) was observed in those on diet T₂ (0.10g CP + 4 L of water). Similarly, birds on diet T₃ had the highest slaughter weight, whereas those on diet T₅ showed the lowest. The defeathered weight (DW) was greatest in the control group (no cinnamon) and in birds fed diet T₃, while the lowest DW was obtained from birds on diet T₅ (0.40g CP + 4 L of water). Significant increases were also noted in the weights of wings, thighs, drumsticks, back, breast, and shanks of broilers receiving diet T₃ compared to the other treatments.

Table 1: Effect of cinnamon powder on carcass characteristics of broiler chicken at 3 weeks

Parameters (g)	T ₁	T ₂	T ₃	T ₄	T ₅	SEM
Live weight	680.20 ^b	580.45 ^c	730.16 ^a	692.11 ^b	617.69 ^c	21.45
Slaughter weight	650.27 ^b	499.13 ^c	860.25 ^a	804.14 ^b	592.09 ^c	10.25
Defeathered weight	490.11 ^a	444.15 ^b	489.02 ^a	440.18 ^b	405.69 ^c	11.35

Parameters (g)	T ₁	T ₂	T ₃	T ₄	T ₅	SEM
Wings	30.26 ^b	29.73 ^c	35.79 ^a	37.70	30.19 ^b	2.40
Thigh	50.11 ^b	50.85 ^b	55.14 ^a	50.06 ^b	50.30 ^b	1.75
Drumstick	40.50 ^{ab}	35.09 ^b	42.49 ^a	40.68 ^{ab}	40.73 ^{ab}	1.35
Back	30.71 ^b	30.58 ^c	38.49 ^a	30.33 ^b	30.28 ^b	1.47
Breast	130.20 ^b	140.35 ^{ab}	145.46 ^a	129.51 ^b	130.55 ^b	5.62
Shank	10.19 ^c	15.01 ^b	16.68 ^a	15.50 ^b	10.99 ^c	0.45

^{abcd} means along the same row with different superscript are significantly ($p < 0.05$) different
SEM= Standard error of mean, T₁= 0.00g cinnamon powder, T₂= 0.10g cinnamon powder, T₃= 0.20g cinnamon powder, T₄= 0.30g cinnamon powder and T₅= 0.40g cinnamon powder
The influence of cinnamon powder on the internal organs of broiler chickens at 3 weeks is presented in Table 2. Dietary treatments had a significant effect ($p < 0.05$) on the liver, lungs, kidney, proventriculus, and abdominal fat. Broilers receiving 0.20 g CP per 4 litres of water showed the largest liver weights, while the control group recorded the lowest. Birds on diet T₃ had significantly heavier lungs compared to other treatments. The highest kidney weight (1.65 g) was observed in birds fed diet T₃, whereas the lowest kidney weight was found in those given 0.30 g CP per 4 litres of water (T₄). The proventriculus weight was significantly greater in broilers fed diets containing 0.30 g and 0.40 g CP per 4 litres of water (T₄ and T₅), which were the heaviest among all treatment groups.

Table 2: Effect of cinnamon powder on internal organ of broiler chicken at 3 weeks

Parameters (%)	T ₁	T ₂	T ₃	T ₄	T ₅	SEM
Liver	19.11 ^c	22.61 ^b	24.19 ^a	18.25 ^c	21.25 ^b	1.25
Lungs	3.39 ^c	4.95 ^b	4.85 ^a	4.71 ^{ab}	3.67 ^c	0.25
Kidney	1.01 ^c	1.09 ^b	1.65 ^a	0.59 ^c	1.06 ^b	0.01
Proventriculus	1.36 ^c	3.07 ^b	3.61 ^b	4.98 ^a	4.63 ^a	0.02
Bile	0.90	0.55	0.93	0.41	0.79	0.01
Crop	3.10	3.56	3.99	3.58	3.02	0.01
Heart	4.49	4.39	4.88	4.67	4.28	0.02
Abdominal fat	1.27 ^c	3.54 ^b	1.11 ^c	3.89 ^a	4.77 ^a	0.14

^{abcd} means along the same row with different superscript are significantly ($p < 0.05$) different
SEM= Standard error of mean, T₁= 0.00g cinnamon powder, T₂= 0.10g cinnamon powder, T₃= 0.20g cinnamon powder, T₄= 0.30g cinnamon powder and T₅= 0.40g cinnamon powder
Table 3 presents the effect of cinnamon powder on carcass characteristics of broiler chickens at 6 weeks. Dietary treatments had a significant influence ($P < 0.05$) on the measured parameters. Broilers fed 0.20 g CP per 4 litres of water recorded the highest live weight (2120.99 g), while those given 0.10 g CP per 4 litres of water had the lowest (1546.36 g). Slaughter weight was greatest in birds fed diet T₃ and lowest in those on diet T₄. The wings, thighs, breast, drumstick, and shank weights were all higher in birds supplemented

with 0.20 g CP per 4 litres of water compared to other groups. In addition, back weight was significantly higher in the control and T₃ groups, whereas the lowest back weight was recorded in birds receiving 0.30 g CP per 4 litres of water (T₄).

Table 3: Effect of cinnamon powder on carcass characteristics of broiler chicken at 6 weeks

Parameters (g)	T ₁	T ₂	T ₃	T ₄	T ₅	SEM
Live weight	1926.92 ^b	1546.36 ^d	2120.99 ^a	1850.11 ^c	1920.61 ^b	60.25
Slaughter weight	1670.01 ^b	1400.24 ^c	1970.22 ^a	1420.03 ^c	1620.33 ^b	55.22
Defeathered weight	1477.36 ^c	1220.21 ^c	1830.75 ^a	1420.01	1630.41 ^a	50.11
Wings	145.22 ^b	120.29 ^b	176.80 ^a	104.15 ^c	110.11 ^c	5.37
Thigh	206.01 ^b	160.92 ^c	240.63 ^a	160.12 ^c	230.17 ^a	1.25
Back	154.59 ^a	130.53 ^b	159.36 ^a	110.29 ^c	140.83 ^b	3.77
Breast	450.54 ^a	330.61 ^c	490.87 ^a	335.41 ^c	4.25 ^b	11.37
Drumstick	170.44 ^b	130.91 ^c	176.29 ^a	135.91 ^c	170.59 ^b	10.38
Shank	48.22 ^c	45.72 ^c	70.15 ^a	50.21 ^b	70.11 ^{ab}	0.58

^{abcd} Means along the same row with different superscript are significantly ($p < 0.05$) different SEM= Standard error of mean, T₁= 0.00g cinnamon powder, T₂= 0.10g cinnamon powder, T₃= 0.20g cinnamon powder, T₄= 0.30g cinnamon powder and T₅= 0.40g cinnamon powder Table 4 shows the effect of cinnamon powder on the internal organs of broiler chickens at 6 weeks. Significant differences ($P < 0.05$) were observed among the dietary treatments for the parameters measured. The largest liver weight (48.47 g) was recorded in birds fed diet T₃, while the smallest (39.20 g) occurred in those on diet T₁. Birds receiving 0.10 g CP per 4 litres of water had larger lungs, proventriculus, and abdominal fat compared to other groups. The heaviest kidney (5.89 g) was found in broilers fed 0.20 g CP per 4 litres of water, whereas the lightest kidney (1.21 g) was observed in those given diet T₅. Similarly, heart weight was highest in birds on 0.20 g CP per 4 litres of water and lowest in those on 0.30 g CP per 4 litres of water (T₄).

Table 4: Effect of cinnamon powder on internal organ of broiler chicken at 6 weeks

Parameters (%)	T ₁	T ₂	T ₃	T ₄	T ₅	SEM
Liver	39.20 ^c	44.35 ^b	48.47 ^a	43.45 ^b	40.34 ^c	0.35
Lungs	10.52 ^a	10.70 ^a	8.29 ^c	9.40 ^a	11.00 ^a	0.23
Kidney	3.10 ^b	2.29 ^c	5.89 ^a	2.31 ^c	1.21 ^c	0.02
Proventriculus	9.56 ^b	15.12 ^a	8.29 ^c	12.78 ^a	10.54 ^b	0.20
Bile	4.40 ^a	3.66 ^b	2.19 ^c	2.00 ^c	2.02 ^c	0.11
Crop	4.15 ^b	5.09 ^a	3.30 ^c	5.10 ^a	5.39 ^a	0.23
Heart	15.33 ^b	12.00 ^c	17.05 ^a	11.95 ^c	13.29 ^c	1.22
Abdominal fat	14.06 ^b	21.59 ^a	10.33 ^c	19.66 ^a	23.78 ^a	0.75

^{abcd} means along the same row with different superscript are significantly ($p < 0.05$) different SEM= Standard error of mean, T₁= 0.00g cinnamon powder, T₂= 0.10g cinnamon powder, T₃= 0.02g cinnamon powder, T₄= 0.30g cinnamon powder and T₅= 0.40g cinnamon powder Table 5 shows the influence of cinnamon powder on the organoleptic properties of broiler chickens at three weeks. Significant ($p < 0.05$) differences were recorded among the dietary treatments across the evaluated parameters. Birds fed diet T₂ (0.10 g) and T₃ (0.20 g) scored highest in colour (6.70), rated as moderately light, followed by the control group T₁ (6.40), rated slightly light, while T₄ had the lowest score (4.90), considered slightly dark. Flavour was best in chickens on diet T₃ (7.70), ranked moderately desirable, whereas diet T₄ recorded the lowest score (6.20), rated slightly desirable. Juiciness was highest in birds fed T₃ (7.40), classified as moderately juicy, while the lowest values were observed in T₁ (5.40) and T₅ (5.50), both rated intermediate. Tenderness was greatest in chickens on diet T₃, while the control group (0.00 g cinnamon powder) had the lowest tenderness score. Overall acceptability was highest in birds fed diet T₃ (0.20 g), followed by T₂, with the other cinnamon-supplemented diets ranking lower.

Table 5: Effect of cinnamon powder on organoleptic properties of broiler chicken at 3 weeks

Parameters	T ₁	T ₂	T ₃	T ₄	T ₅	SEM
Colour	6.40 ^b	6.70 ^a	6.70 ^a	4.90 ^c	5.60	0.14
Flavor	6.70 ^b	7.10 ^{ab}	7.70 ^a	6.40 ^b	6.20 ^c	0.15
Juice	5.40 ^d	6.70 ^b	7.40 ^a	6.20 ^c	5.50 ^d	0.17
Tender	4.90 ^d	6.90 ^a	7.00 ^a	6.60 ^b	5.90 ^c	0.19
Acceptance	5.60 ^c	6.70 ^b	7.70 ^a	5.45 ^c	5.40 ^c	0.20

^{abcd} Means along the same row with different superscript are significantly ($p < 0.05$) different T₁= 0.00g Cinnamon powder (CP), T₂= 0.10g CP, T₃=0.20g CP, T₄= 0.30g CP, T₅= 0.40g CP, SEM= Standard error of Means, Colour: 1= dark, 2= Just dark, 3= Moderately dark, 4= Slightly dark, 5= Intermediate, 6= Slightly light, 7=Moderately Light, 8= Very light, 9= Extremely light, Flavour: 1= Extremely undesirable, 2= Very undesirable, 3= Moderately undesirable, 4= Slightly undesirable, 5 = Intermediate, 6= Slightly desirable, 7= Moderately desirable, 8= Very desirable, 9= Extremely desirable. Juiciness: 1= Extremely dry, 2= Very dry, 3= Moderately dry, 4= Slightly dry, 5 = Intermediate, 6= Slightly juicy, 7= Moderately juicy, 8= Very juicy, 9= Extremely juicy. Tenderness: 1= Extremely tight, 2= Very tight, 3= Moderately tight, 4= Slightly tight, 5 = Intermediate, 6= Slightly loose, 7= Moderately loose, 8= Very loose, 9= Extremely loose. Acceptability: 1= Extremely dislike, 2= Very dislike, 3= Moderately dislike, 4= Slightly dislike, 5 = Intermediate dislike, 6= Slightly tight like, 7= Moderately like, 8= Very like, 9= Extremely like.

The impact of cinnamon powder on the organoleptic qualities of broiler chickens at six weeks is presented in Table 6. Significant ($p < 0.05$) variations were observed among the dietary treatments across the measured parameters. Birds fed diet T₅ (0.20 g cinnamon)

recorded the highest colour score (7.40), rated moderately light. For flavour (7.0), juiciness (6.90), tenderness (6.70), and overall acceptability (7.60), the highest values were obtained in chickens fed diet T₃, which was ranked moderately liked. In contrast, the lowest acceptability score (6.80) was noted in birds fed diet T₄, rated slightly liked.

Table 6: Effect of cinnamon powder on organoleptic properties of broiler chicken at 6 weeks

Parameters	T ₁	T ₂	T ₃	T ₄	T ₅	SEM
Colour	6.60 ^b	5.70 ^c	7.40 ^a	5.10 ^c	6.10 ^c	0.14
Flavor	6.80 ^{ab}	5.50 ^b	7.00 ^a	6.70 ^{ab}	5.60 ^b	0.12
Juice	6.60 ^b	5.90 ^c	6.90 ^a	6.30 ^c	6.90 ^b	0.14
Tender	6.60 ^a	6.70 ^a	6.70 ^a	5.50 ^b	4.10 ^c	0.11
Acceptance	7.10 ^{ab}	7.40 ^{ab}	7.60 ^a	6.80 ^c	7.10 ^{ab}	0.10

^{abcd} Means along the same row with different superscript are significantly ($p < 0.05$) different, T₁= 0.00g Cinnamon powder (CP), T₂= 0.10g CP, T₃=0.20g CP, T₄= 0.30g CP, T₅= 0.40g CP, SEM= Standard error of Means, Colour: 1= dark, 2= Just dark, 3= Moderately dark, 4= Slightly dark, 5= Intermediate, 6= Slightly light, 7=Moderately Light, 8= Very light, 9= Extremely light, Flavour: 1= Extremely undesirable, 2= Very undesirable, 3= Moderately undesirable, 4= Slightly undesirable, 5 = Intermediate, 6= Slightly desirable, 7= Moderately desirable, 8= Very desirable, 9= Extremely desirable. Juiciness: 1= Extremely dry, 2= Very dry, 3= Moderately dry, 4= Slightly dry, 5 = Intermediate, 6= Slightly juicy, 7= Moderately juicy, 8= Very juicy, 9= Extremely juicy. Tenderness: 1= Extremely tight, 2= Very tight, 3= Moderately tight, 4= Slightly tight, 5 = Intermediate, 6= Slightly loose, 7= Moderately loose, 8= Very loose, 9= Extremely loose. Acceptability: 1= Extremely dislike, 2= Very dislike, 3= Moderately dislike, 4= Slightly dislike, 5 = Intermediate dislike, 6= Slightly tight like, 7= Moderately like, 8= Very like, 9= Extremely like.

Discussion

The growth, development, and overall health of chickens depend largely on the efficiency of their digestive system, which influences feed digestion, nutrient absorption, and conversion of feed into meat or eggs for human use. The improvements observed in live weight, dressed weight, and primal cuts (drumstick, thigh, breast, back, and wings) among broilers fed varying levels of cinnamon inclusion align with the findings of Qaid *et al.* (2022), who reported significantly higher liver and lymphoid organ values (bursa, thymus, spleen) in broilers supplemented with cinnamon bark powder. This could be as results of improved nutrient utilization since cinnamon contains bioactive compounds (cinnamaldehyde, eugenol, tannins, flavonoids) that enhance digestive enzyme activity, improve gut health, and reduce pathogenic load. At 0.20 g inclusion, these effects are maximized without causing antinutritive or metabolic stress. At both the 3rd and 6th week, broilers given 0.20 g CP + 4 L water exhibited superior carcass and organ characteristics, indicating efficient

intestinal function and nutrient absorption (Yang *et al.*, 2021). These positive outcomes are attributed to the bioactive compounds of cinnamon, mainly cinnamaldehyde and trans-cinnamaldehyde, which enhance growth hormone secretion (Akter *et al.*, 2022), stimulate intestinal cell development, and promote tissue growth. Ding *et al.* (2022) also highlighted cinnamon's multifaceted effects, including stimulating digestive enzyme secretion and enhancing pancreatic and intestinal lipase activity.

The increases in carcass and organ characteristics in this study are consistent with earlier findings where the combination of cinnamon powders significantly improved dressed breast, back, and wing weights. Similarly, Qaid *et al.* (2024) demonstrated notable improvements in breast, thigh, gizzard, liver, and lymphoid organ weights in cinnamon supplemented groups compared with controls. Thus, this might be the optimal inclusion likely improved feed conversion efficiency, allowing more nutrients to be directed toward muscle accretion (breast, thigh, drumstick) rather than fat deposition. Too little inclusion (<0.20 g) may not yield enough bioactive impact, while higher levels (>0.20 g) may exert antimicrobial or astringent effects that impair feed palatability and nutrient absorption. García-García *et al.* (2024) further reported that cinnamon supplementation at 0.1 - 0.4% increased abdominal fat content relative to control diets and this as a result of moderate cinnamon inclusion helps stabilize cell membranes and muscle proteins by limiting lipid peroxidation. This preserves muscle quality post-slaughter.

With regard to meat quality, significant variations were observed among treatments. Chickens fed diet T₃ (0.2 g) showed improved meat favour and aroma, texture, juiciness and colour stability scores and this consistent with the reports of Raluca-Aniela *et al.* (2024); Jung *et al.*, (2024); Park and Kim (2022); Barido *et al.* (2022) and Ashour *et al.* (2020) who documented cinnamon's positive effect on meat colour, enhanced flavour and juiciness and this might be as a result of cinnamon antioxidant and antimicrobial effects that slow rancidity, enhancing freshness and subtle aroma without overpowering the natural chicken flavor. At 0.20 g, the balance between enhancement and neutrality is achieved higher inclusion may impart strong or bitter notes disliked by consumers. However, antioxidant protection prevents excessive protein denaturation, maintaining tenderness and water-holding capacity. This translates to juicier and more palatable meat while cinnamon's phenolic compounds stabilize muscle pigments, contributing to better visual appeal without discoloration.

Conclusion

The present findings demonstrate that dietary supplementation with 0.20 g of cinnamon powder in 4 L of water for birds represents an optimal inclusion level for improving carcass traits and enhancing sensory attributes of broiler meat. This optimal dose is likely attributable to the bioactive phytochemicals in cinnamon particularly cinnamaldehyde and eugenol which may enhance muscle development, reduce lipid peroxidation, and improve flavor development. Broilers fed 0.20 g cinnamon exhibited improved carcass yield and

better consumer-accepted sensory characteristics, including superior tenderness, juiciness, aroma, and flavor. These results suggest that low-level cinnamon supplementation can serve as a natural feed additive that enhances carcass quality and aligns with increasing demand for antibiotic-free poultry production systems.

As the awareness increases to reduce synthetic growth promoters and antibiotics in poultry production, cinnamon appears promising as a natural alternative. Integrating cinnamon into commercial broiler diets could support sustainable and health-conscious production while maintaining enhancing product quality. Future commercialization may also stimulate the development of standardized cinnamon-based feed formulations and complementary phytogetic blends.

Recommendations

The inclusion of 0.20 g cinnamon powder in 4 Litre of water is recommended as an optimal level for broilers to improve carcass characteristics, enhance flavor and tenderness, and increase consumer acceptability. Its potential as a low-cost natural additive position it as a promising substitute for synthetic growth promoters in sustainable poultry production.

Farmers

1. Use 0.20 g per 4 Litre for birds' dietary inclusion: This level has been shown to improve carcass yield (breast, thigh) and enhance meat tenderness, juiciness, and flavor.
2. The introduce cinnamon from starter to finisher phases will continuous supplementation allows optimal physiological response, especially antioxidant and digestion-enhancing effects.
3. Use finely milled cinnamon powder: Fine particle size improves uniform distribution in feed and enhances nutrient absorption.
4. Combine with good management: Benefits are maximized under hygienic housing, proper nutrition, and adequate vaccination.
5. Avoid excessive inclusion: Higher levels (>0.20–0.30 g) may not improve quality further and may reduce palatability.
6. Cost–benefit consideration: Cinnamon is relatively affordable, and its use may reduce dependence on synthetic growth promoters or antibiotics.

Poultry Feed Industry

1. Standardize cinnamon-based premixes: Develop commercial premixes at ~0.2% inclusion to ensure uniformity and farmer accessibility.
2. Promote cinnamon as a natural growth/quality enhancer: Highlight benefits such as improved carcass traits, enhanced consumer acceptability, and natural antioxidant support.
3. Combine with other natural additives: Synergy with probiotics, ginger, turmeric, or essential oils could further improve gut health and meat quality.

4. Evaluate shelf stability: Ensure that cinnamon-containing feed maintains potency over storage time.
5. Replace or reduce synthetic additives: Can be marketed as a safer alternative to antibiotic growth promoters (AGPs) to improve public perception.

Consumers

1. Cinnamon-fed broiler meat is preferred: Enhanced taste, tenderness, aroma, and reduced oxidation.
2. Longer shelf-life: Due to antioxidant effects, meat may retain freshness better, especially during cold storage.

Future Researchers

1. Dose response studies: Evaluate intermediate levels (e.g., 0.15, 0.25, 0.30 g) to refine the optimum inclusion level.
2. Mechanistic studies: Explore mechanisms behind improved sensory quality: Antioxidant pathways, Effects on muscle biochemical composition and Gut microbiota modulation
3. Cinnamon source standardization: Compare feed-grade cinnamon vs. pharmaceutical-grade or essential oil extract.
4. Interactions with other phytochemicals: Determine whether combined additives provide additive/synergistic benefits.
5. Shelf-life studies: Evaluate oxidative stability of cinnamon-fed broiler meat during cold or retail storage.
6. Meat safety research: Evaluate microbial load reduction (e.g., *Salmonella*, *E. coli*) in carcass and stored meat.

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