



**PERFORMANCE, HAEMATOLOGICAL INDICES AND
ORGANOLEPTIC PROPERTIES OF BROILER CHICKENS FED DIET
CONTAINING CINNAMON (*Cinnamomum cassia*) AS FEED ADDITIVE**

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ABSTRACT

This experiment was conducted to determine the performance, hematological indices and organoleptic properties of broiler chicken fed different inclusion levels of cinnamon powder as feed additive. Three Hundred 300 day old Agrited Lohman strain of broiler chicken were used for the experiment and were randomly distributed to five treatments of 60 birds each with three replicate consisting of 20 birds per replicate in a Completely Randomized Design (CRD). The dietary treatment consisted of T1, T2, T3, T4, and T5 with cinnamon supplementation at 0.0g, 0.5g, 1.0g, 1.5g, and 2.0g respectively in drinking water. Feed and water were supplied *ad libitum* and the experiment lasted for seven (7) weeks. At the end of the 7th week, data were collected on growth performance, organoleptic properties and hematological indices by starving bird of feed overnight. Blood samples for analysis were collected in different set of bottles from three birds per treatment through their wing vein. The result showed that there is significant difference ($p < 0.05$) across the body weight gain, feed intake and feed conversion ratio and the haematological parametres measured. However, the results of organoleptic properties also indicate significant difference ($p < 0.05$) among the properties tested. Based on the results of this study, it was concluded that inclusion T5 with 2.0g of cinnamon powder in chicken drinking water improved performance and hematological status of the chickens without compromising it performance, health status and overall meat quality as such its recommended to poultry farmers

Keywords: Broiler chicken, Cinnamon, Haematological indices, Organoleptic properties

INTRODUCTION

Poultry provides nutritionally beneficial food containing high-quality protein accompanied by a low proportion of fat. Agriculturist and nutritionists have generally agreed that developing the poultry industry of Nigeria is the fastest means of bridging the protein-deficiency gap presently prevailing in the country. Poultry production has an important economic, social, and cultural benefit and plays a significant role in family nutrition in developing countries (Delgado *et al.*, 1999). It has been estimated that 80% of the poultry population in Africa is found in traditional scavenging systems (Gueye, 2000). In most tropical countries it is based mainly on scavenging production systems, which makes substantial contributions to household food security throughout the developing world (Muchadeyi *et al.*, 2007). Indigenous breeds still contribute meaningfully to poultry meat and egg production and consumption in developing countries, where they make up to 90% of the total poultry population. A Central Statistics Agency CSA (2015) report revealed that 95.86% of the total poultry population comprises indigenous birds, while 2.79 hybrids and 1.35% are exotic breeds. According to the Food and Agricultural Organization, global poultry output increased from approximately 115 million tons in 2016 to around 136 million tons in 2023. The production of poultry has increased significantly in tandem with the dramatic uptick in meat and egg demand. Feed accounts for between 65 and 70 percent of total production costs,



making it the single largest expense in the chicken industry. This is why it's important to maximize the transformation of poultry feed into feed with a high biological value while taking as many steps as possible to protect feed quality and reduce feed costs (Mohamed *et al.*, 2013). The production of animal is determined by its physiological status.

Aromatic plants have been used worldwide for centuries as food and for medicinal purposes. Various biological activities, such as antioxidative (Botsoglou *et al.*, 2002; Giannenas *et al.*, 2005; Florou-Paneri *et al.*, 2006), anticoccidial (Christaki *et al.*, 2004) or antimicrobial (Govaris *et al.*, 2007; Botsoglou *et al.*, 2010) properties have been identified in these plants. Consequently, an increasing interest in the use of these products in poultry nutrition has been experienced especially since the complete ban by the European Union countries in 2006 (EU, 2005) on the use of antibiotics as growth promoters in animals. Cinnamon (*Cinnamomum verum*) is an herb commonly used as a spice in human food and has received considerable attention as an additive in poultry nutrition. Cinnamon is obtained from several trees from the genus *Cinnamomum* that is used in both sweet and savory human foods. In addition to giving flavor to foods, cinnamaldehyde which is the predominant compound of cinnamon, and it presents antimicrobial and antioxidant activity (Lee *et al.*, 2004; Faix *et al.*, 2009). According to Al-Kassie (2009), the use of cinnamon extract improves feed efficiency and performance of broilers due to substances such as cinnamaldehyde and eugenol. Cinnamon extract inhibits *Helicobacter pylori* at the concentration range of common antibiotics, its antimicrobial properties are mainly related to its cinnamaldehyde content, followed by eugenol and carvacrol contents (Tabak *et al.*, 1999).

Feed additives are an ideal tool to boost the profits of poultry farmers. Natural medicinal products originating from herbs, spices, and various plant extracts had received particular attention as possible alternatives to antibiotic growth promoters (Guo, 2003; Hernandez *et al.*, 2004). Being natural, non-toxic, residue-free, easy availability, and their beneficial effects viz. appetizer, increased digestive enzymes secretion, immuno-stimulant, bactericidal, antiviral and antioxidants made them highly acceptable as natural feed additives for poultry (Singh *et al.*, 2014). Cinnamon (*Cinnamomum zeylanicum*) commonly known as “dalchini” is one of the oldest medicinal plants, widely used as a condiment in India and indigenous to Sri Lanka and South India (Jakhetia *et al.*, 2010).

There have been resurgence of interests for “all natural” medicinal plants like herbal feed additives, plant extracts with growth, flavour, colour enhancing, antioxidant and antibacterial activities (Adodo, 2002; Omojasola and Awe, 2004). Herbal formulations have proved useful gain and less meat-bone ratio beyond doubt. However, there is dearth of data on efficacy of herbal products especially on carcass characteristics and cooking attributes. This study therefore presents the effect of dietary cinnamon powder on the hematological indices and organoleptic properties of broiler chickens.

MATERIALS AND METHODS

Experiment Site

The experiment was conducted at the Poultry Unit of Teaching and Research Farm, Bauchi State College of Agriculture, Bauchi. Bauchi is located on Latitude 100⁰ -17' N and longitude 90⁰ -49' E, with an altitude of 690.2 meters above sea level. Bauchi falls within the Northern guinea savannah and is bordered by Borno and Yobe states to the north, Kaduna and Kano to the west, Gombe to the East and Plateau state to the South (Anonymous, 2023)

Preparation and Collection of Test Ingredient

The test ingredient used was cinnamon powder (cinnamon has attracted attention from researchers as a natural product with numerous health benefits for poultry. The essential oils in



cinnamon, in particular, are of interest because of their antioxidant, anti-microbial, anti-inflammatory, antifungal, and hypocholesterolaemic effects, in addition to their ability to stimulate digestive enzymes in the gut Lin *et al.*, 2003; Shan *et al.*, 2007 and Rao and Gan, 2014). It was procured from Muda Lawal Market, Bauchi and grinded to powder form.

Experimental Animal and Management

Agrited Lohmann Strain of Broiler Chicken was purchased from, Ibadan, Oyo State Nigeria. Three hundred (300) day old chicks were used for the research; the chicks were weighed on arrival (initial weight) and were randomly assigned to five (5) treatments in a Completely Randomized Design with 60 birds per treatment. Each treatment was further subdivided into three (3) replicates of twenty (20) birds each. The chicks in the control group (T1) were provided with standard basal diet (starters marsh) from 0-28 day and growers marsh from 28-56 day and known quantity of cinnamon powder were supply in their drinking water as follows: T1(0.0) without cinnamon powder T2 (0.5g), T3 (1.5g), T4 (2.0g) and T5 (2.5g) of water for a period of 56 days. The birds were kept in deep litter system with feeders and drinkers. Health conditions were determined by closely observing the chickens for signs of ill health. The birds were routinely vaccinated and medicated at monthly interval against diseases such as Newcastle, Gumboro and Coccidiosis. All necessary routine management practices were strictly observed throughout the period of the study. The experiment lasted for seven (7) weeks.

Experimental Diets

Birds were fed *ad-libitum* on a broiler starter diet containing Crude Protein of 18%, Metabolizable energy of 3000Kcal/Kg for 4 weeks, followed by grower diet containing Crude Protein of 17%, Metabolizable energy of 2300Kcal/Kg for another 3 weeks making the total of 7 weeks

Table 1: Composition of Experimental Diets Fed to Broiler Chicken

Ingredient (%)	Diets				
	T1	T2	T3	T4	T5
Maize	65.00	67.00	67.00	67.00	67.00
Full-Fat Soya bean	15.00	15.50	14.00	13.00	12.00
Groundnut Cake	16.00	13.50	15.00	16.00	17.00
Bone Meal	3.00	3.00	3.00	3.00	3.00
Common Salt	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Vit/Min. Premix **	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Calculated Analysis (%)					
Metabolizable Energy (Kcal/kg)	3000	3016	3022	3025	3030
Crude Protien (%)	18.3	18.1	18.15	19.06	18.37
Crude Fibre (%)	3.80	3.40	3.75	3.55	3.33
Ether Extract (%)	0.61	0.55	0.58	0.55	0.59
Calcium (%)	1.15	1.15	1.15	1.15	1.15
Available P. (%)	0.60	0.60	0.61	0.60	0.60
Methionine (%)	0.51	0.51	0.52	0.51	0.51
Lysine (%)	1.05	1.00	1.01	1.05	1.10



Test Ingredient

Certain measured quantity of cinnamon was dissolved in water per treatment and replicates respectively. The layout goes thus:

- T1: 0g cinnamon/5litres of water
- T2: 0.5g cinnamon/5litres of water
- T3: 1.0g cinnamon/5litres of water
- T4: 1.5g cinnamon/5litres of water
- T5: 2.0g cinnamon/5liters of water

Data Collection

Performance Parameters:

Performance parameters measured and calculated include initial body weight, final body weight, weight gained, feed intake, feed conversion ratio. Feed intake and body weight gain will be taken weekly and will be used to calculate average daily feed intake and average daily weight gain. Mortality will be recorded as it occurs during the experiment.

Haematological Study

At the end of the finisher phase, three (3) birds were randomly selected from each treatment and 2.0ml of blood was collected through the wing vein with the aid of a sterilized needle into sterile bottles

Containing Ethylene Diamine Tetraacetic Acid (EDTA) as anti-coagulant to determine haematological parameters. Blood samples meant for determining biochemical indices (total protein, albumin, globulin, urea, cholesterol and triglyceride) collected into the bottles without EDTA.

Samples was then taken to the Clinical Pathology Laboratory, Abubakar Tafawa Balewa University Teaching Hospital Bauchi to determine packed cell volume (PCV), haemoglobin (Hb), red blood cells (RBC), white blood cells count (WBC), lymphocytes, neutrophil. Haematological and biochemical parameters would be determined using the standard clinical chemistry procedure (Olorede and Akinloye, 2002)

Meat Quality Characteristics

Sensory evaluation was conducted within 30 minutes of preparation while focusing on the degree of cinnamon taste and flavor. Sensory evaluation was conducted in a sensory evaluation room by a trained 20 member panel (consisting of 10 male and 10 female college students), who scored sensory attributes of colour (meats tested for colour was exposed to air for at least an hour ('blooming')). The color was determined by the reflectance of myoglobin, seen through a mesh of water molecules, the thickness of which is pH-dependent), flavor (the sensory evaluation appeared to be the only reliable method for assessing meat flavor), for juiciness (scores were given in the beginning and again at the completion of mastication.), tenderness (tenderness is measured as the force or energy required to cut (penetrate), tear, or compress (deform) the meat) and overall acceptability using a 7-point hedonic scale (4 = dislike extremely; 5 = neither like nor dislike; 7 = like extremely) using the procedure of Choi *et al.*, 2016.

Statistical Analysis

All data generated were subjected to a one-way analysis of variance (ANOVA) using IBM SPSS statistics 25 for windows (SPSS, 2017). Means were separated using Duncan's Multiple Range Test of the same software, at $p < 0.05$ level of significance.

RESULTS AND DISCUSSION

Growth Performance

Growth performance of the broiler chickens fed diets with cinnamon powder is presented in Table 2.

Table 2: Performance of Broiler Chicken Fed Dietary level of Cinnamon Powder

Parameters	Diets					SEM
	T1	T2	T3	T4	T5	
Initial weight (g/bird)	541.61	538.54	540.52	541.01	550.04	30.45
Final weight (g/bird)	1286.00 ^b	1247.00 ^{b^c}	119.52 ^c	1298.85 ^b	1679.11 ^a	52.40
Daily weight gain (g/bird)	30.90 ^b	28.40 ^b	23.88 ^c	29.07 ^b	50.06 ^a	1.87
Daily feed intake (g/bird)	78.23	75.67	73.98	74.00	73.11	2.21
Feed conversion ratio	2.38 ^b	2.41 ^b	3.30 ^c	2.45 ^b	1.39 ^a	0.30
Survivability rate (%)	98.50	99.00	98.00	100.00	100.00	-

^{abc} – means within the same row with different superscript are significantly difference (p>0.05).

The final body observed during the overall experimental period were significantly increased when compared to the control group (T1). The body weight of the T5 (2.0g Cinnamon) was significantly higher than the other treatments, while there was no significant difference between the T2 (0.5g cinnamon) and T3 (1.0g cinnamon). Thus, the plateau levels required to BW appeared to be attained in the diet containing 2.0g cinnamon powder. The reason for the increased body weight in T2 may have been due to increased serum immunoglobulin via the heavier weight of the immune organs as well as the antibacterial activity (Hernandez *et al.*, 2004; Valero and Salmeron, 2003; Dickens *et al.*, 2000; Ouattara *et al.*, 1997) and antioxidation activity (Calucci *et al.*, 2003; Park and Park, 2000) of 2.0g cinnamon in the diets. The Feed Intake was also slightly higher in T5 than in control group, but there were no significant differences among treatment group. The Feed conversion ratio was significantly higher in control 0.0g cinnamon powder than in the other treatment groups with are significant differences among treatment. This is study shows that the growth performance of broiler chickens could be improved by providing diets containing cinnamon powder. These results suggest that the essential oils contained in cinnamon promote the growth of muscular tissue (Hernandez *et al.*, 2004) in broiler chickens. Hernandez *et al.* (2004) reported that the body weight gain, feed intake and feed efficiency of broiler chickens fed a diet supplemented with cinnamon, oregano and pepper oil extracts at 200 ppm were similar to those of broiler chickens fed a diet supplemented with placebo, antibiotics and labiatae extract for 42 days (Hernandez *et al.*, 2004). Furthermore, the values reported in their study were lower than the results obtained in the present study. In addition, the acceptance and preference of cinnamon flavored diets was reported to increase in broiler (Bennett *et al.*, 1998), which supports the results of the present study.

Haematological Indices

The influence of cinnamon powder on the blood haematological parameters of broiler chicken was indicated in Table 3.

Table 3: Effect of Cinnamon Powder on Haematological Indices of Broiler Chickens

Parameters	Diets					SEM
	T1(0.0g)	T2 (0.5g)	T3 (1.0g)	T4 (1.5g)	T5 (2.0g)	
WBC ($\times 10^3/\text{mm}^3$)	24.06 ^{ab}	21.28 ^b	19.42 ^c	23.92 ^{ab}	26.38 ^a	0.25
RBC ($\times 10^3/\text{mm}^3$)	2.09 ^{ab}	1.53 ^c	1.68 ^b	2.08 ^{ab}	2.30 ^a	0.06
HB (g/dl)	9.00 ^a	6.20 ^c	6.60 ^b	8.61 ^{ab}	8.60 ^{ab}	0.81
MCV (fL)	153.30 ^c	154.69 ^{bc}	159.60 ^a	154.82 ^{bc}	155.34 ^b	0.68
MCH (pg)	39.42 ^b	40.09 ^b	38.86 ^c	41.08 ^a	41.22 ^a	0.38
MCHC (%)	25.70 ^b	25.80 ^b	24.32 ^c	26.51 ^a	26.31 ^a	0.20
LYM (%)	98.10 ^a	97.06 ^{ab}	93.31 ^c	96.02 ^b	98.05 ^a	0.42

^{abc}- Means along the same row with different superscripts are significantly ($p < 0.05$) different.

WBC = White blood cell, RBC = Red blood cell, HGB = Hemoglobin, MCV= Mean corpuscular volume or cell volume. MCH = Mean corpuscular hemoglobin, MCHC = Mean corpuscular hemoglobin concentration, LYM = Lymphocytes. T1 = 0.0 g of cinnamon (Control). T2 = 0.5 g of cinnamon, T3 = 1.0 g of cinnamon, T4 = 1.5 g of cinnamon, T5 = 2.0 g. SEM = Standard error of mean.

Between the dietary treatment and the parameters examined, there were significant variations ($p < 0.05$). White blood cell (WBC) counts were highest (26.38 mm^3) in chickens fed diet 5 (2.0 g cinnamon in water), and lowest (19.42 mm^3) in bird fed diet T3 (1.0 g of cinnamon powder in water). The maximum red blood cell (RBC) count (2.30 mm^3) was found in bird fed T5, whereas the lowest RBC count (1.53 mm^3) was found in chickens fed diet T2. The maximum hemoglobin (HGB) (9.00 g/dL) was found in chickens fed T1, whereas the lowest HGB (6.20 g/dL) was found in chickens fed diet T2. Chickens fed diet T3 (1.5 g of cinnamon in water) had the highest mean corpuscular volume (159.60 fL), while bird fed diet T1 had the lowest MCV value (153.30 fL). The chickens fed diet T5 had the highest mean corpuscular haemoglobin (MCH) (41.28 pg), while bird fed diet T3 had the lowest MCH (38.56 pg). Bird fed diet T4 and T5 had the greatest MCHC (26.51% and 26.31%) respectively, followed by chickens fed diet T2 and diet T1 (0.5 g of cinnamon in water and 0.0 g cinnamon in water) with (25.80 % and 25.70 % respectively). Bird fed diet T1 and T5 had the highest Lymphocytes (LYM) (98.10 % and 98.05 %), followed by birds fed diet T3 (93.01 %). The findings of this study revealed that chicken haematological features differ significantly depending on the dietary treatments. The haematological features of chickens fed diet T5 (2.0g cinnamon) showed that they had better haematological characteristics than the cinnamon groups. This finding was in line with Chowlu et al., (2018), who found that adding cinnamon to the feed of broiler chickens at varied levels had a substantial impact on blood profile. Sura (2018) found that using Ceylon cinnamon (*Cinnamomun zeylanicum*) powder in the feed of broiler chickens resulted in a substantial rise in red blood cell, white blood cell, mean corpuscular volume, and hemoglobin.

Meat Quality Characteristics

Meat quality characteristics of broiler chicken as shown in Table 4 indicate there were significant ($p > 0.05$) differences between the dietary treatments and parameters measured for organoleptic of broiler chickens in the experiment.

Table 4: Effect of Cinnamon Powder on Meat Quality Characteristics of Broiler Chickens

Parameters	Diets					SEM
	T1(0.0g)	T2 (0.5g)	T3 (1.0g)	T4 (1.5g)	T5 (2.0g)	
Color	5.60 ^a	4.00 ^c	4.00 ^c	4.80 ^b	4.69 ^b	0.04
Flavor	6.00 ^b	5.50 ^c	6.40 ^a	5.30 ^c	4.98 ^c	0.18
Tenderness	4.37 ^c	5.27 ^b	5.40 ^a	4.13 ^c	4.44 ^c	0.08
Acceptability	7.00 ^a	6.80 ^b	6.40 ^{bc}	5.00 ^c	5.15 ^c	0.24
Juiciness	5.00 ^b	5.20 ^b	6.20 ^a	3.20 ^c	3.46 ^c	0.16

^{abc} Means along the same row with different superscripts are significantly ($p < 0.05$) different, SEM = Standard Error of the Mean.

There were significant ($p < 0.05$) differences between the dietary treatments and the parameters measured for organoleptic properties of broiler chickens in the experiment. The chickens fed diet T1 (control) had the highest meat colour (5.60) which was rated slightly light while other treatments were rated slightly dark. This observation was in line with the findings of Homseng *et al.* (2019) who reported the usage of cinnamon in the diet of broiler chicken had no effect on meat colour irrespective of treatment groups. Govindarajan *et al.* (2018) also revealed that meat colour was not influenced with the use of cinnamon oil and sodium butyrate in the diet of broiler chicken. However, the discovery in this resent study disagreed with the findings of Park (2008); Jaswinder *et al.* (2014); Raskar *et al.* (2018); Akinade (2012). These authors claimed significant enhancement of cinnamon powder on meat colour.

Flavor was highest (6.40) for chickens fed with diet T3 which was ranked moderately desirable while chickens fed diet T4 and T5 had the lowest (5.30 and 4.98 respectively) which was considered intermediate. This corroborated the findings of Jaswinder *et al.* (2014) who reported that flavor in the use of cinnamon (*Cinnamomum cassia*) powder as a phytobiotic growth promoter in broiler chickens was improved compared to control group. However, the enhanced flavor characteristics discovered in this study against the findings of Govindarajan *et al.* (2018). This author claimed non-significant enhancement of cinnamon powder on flavor. He reported that the supplementation of cinnamon oil and sodium butyrate in the diet of broiler had no influence on the flavor of the meat quality.

The highest tenderness was observed in bird fed diet T3 (5.40) which was rated slightly hard while the lowest tenderness was obtained in meat fed the other diets which was ranked slightly soft. This was in agreement with the findings of Jaswinder *et al.* (2014) who reported that tenderness was significant in the use of cinnamon (*Cinnamomum cassia*) powder as a phytobiotic growth promoter in broiler chickens compared with the control group. However, the enhanced tenderness characteristics of meat quality discovered in this study against the findings of Govindarajan *et al.* (2018) and Homseng *et al.* (2019). These authors claimed non-significant enhancement of cinnamon powder on tenderness. Homseng *et al.* (2019) reported that the usage of cinnamon in the diet of broiler chicken had no effect on meat tenderness irrespective of treatment groups. This is in accordance with the work of Govindarajan *et al.* (2018) who also revealed that meat tenderness was not influenced with the use of cinnamon oil and sodium butyrate in the diet of broiler chicken.

The chickens fed diet T1 had the highest acceptability (7.00) rated very like while the diet T4 had the lowest (5.00) which was considered intermediate. This was in line with the findings of Homseng *et al.* (2019) who reported that acceptability was significantly higher in groups fed cinnamon powder compared with the control. Raskar *et al.* (2018) also revealed that the use of cinnamon in the diet of broiler chickens had improved meat quality. However, no



non-significant effect on acceptability has been reported on the use of cinnamon in the diet of broiler chickens.

The value (6.20) was recorded highest for juiciness for chicken meat fed diet T3 which was considered slightly juicy while the lowest (3.20) was observed for chickens fed diet T4 which was rated moderately dry. This was in agreement with the findings of Raskar *et al.*, (2018) who revealed that the use of cinnamon in the diet of broiler chickens had an improved meat quality. However, the enhanced juiciness characteristics discovered in this present study differs from the works of Govindarajan *et al.*, (2018) and Homseng *et al.* (2019). These authors claimed non-significant enhancement of cinnamon powder on juiciness. Homseng *et al.* (2019) reported that using cinnamon in the diet of broiler chicken had no effect on meat juiciness irrespective of treatment groups. This also corroborated with the work of Govindarajan *et al.* (2018) who also revealed that meat juiciness was not influenced with the use of cinnamon oil and sodium butyrate in the diet of broiler chicken.

CONCLUSION AND RECOMMENDATION

Based on the finding of this study, it can be concluded that:

- i. Cinnamon powder has significance variation in blood hematological parameters measured and organoleptic properties of broiler without any detrimental effect on productive as well as health status of broiler chickens.
- ii. The results of the study showed that feeding dietary cinnamon powder to broiler chickens improved the shelf life and quality of chicken meats with increasing growth performance via stimulation of the growth of cells of major immune organs and boosting the immunoglobulin IgG content.
- iii. Additionally, the results of this study indicated that amending the diet of broilers with 2.0g cinnamon powder can improve the quality of chicken meat and maximize the production yields of broiler chickens.

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