GUT MORPHOLOGY OF BROILER CHICKENS ADMINISTERED CINNAMON POWDER AS ORGANIC GROWTH PROMOTER

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ABSTRACT
This study determined the effect of cinnamon powder on the gut morphology of broiler chickens. One hundred and forty (140) one- day old broiler chicks were distributed into five (5) treatments in a completely randomized design. Treatment 1 (T1) diet contained antibiotics and served as the control; Treatment 2 (T2), Treatment 3 (T3), Treatment 4 (T4) and Treatment 5 (T5) diets contained 1.5g/kg, 3g/kg, 4.5g/kg and 6g/kg cinnamon powder respectively. The study lasted for 49 days. Intestinal samples were collected from the ileum from one bird per replicate and morphometric indices were determined using computer-aided light microscope. Data were collected on villus height, crypt depth, crypt width and muscle thickness of the intestinal segment, and the average measurement of each selected photo was used for analysis. All data collected were subjected to Analysis of Variance using the general linear model in MINITAB 18. Significant ($p< 0.05$) means were separated using Duncan Multiple Range Test as contained in the software. Results at 49 days showed that Birds in treatment 5 had the highest ($p<0.05$) villi height and depth, cryptal depth and width and muscle thickness. 6g/kg cinnamon inclusion can be recommended for broiler chickens to increase nutrient absorption.
Keywords: Antibiotics, Antioxidant, Broilers, Cinnamon, Villi

INTRODUCTION

The fast-growing nature of broilers and their short generation interval has been associated with the use of antibiotic growth promoters in animal feeds. However, the use of antibiotics in the diet is restricted because of their residual effect on birds and in turn adverse effect on human health, environmental hazards and subsequent resistance to bacteria (Reuben *et al.,* 2021). The poultry industry has encountered increasing hurdles since the use of antibiotics as growth enhancers was prohibited. As a result, phytogenic sources have been regarded as a risk-free option. Phytogenics are naturally occurring bioactive compounds that have a positive impact on animal health and development. These natural feed additives are widely accepted as safe. A range of phytogenic feed additives including thyme (*Thymus vulgaris*), clove (*Syzygium aromaticum*), turmeric (*Curcuma longa*), black pepper *(Piper nigram)*, oregano (*Oregano vulgar*), garlic *(Allium sativa*), cinnamon (*Cinnamomum cassia*) have been studied as phytogenic feed additives in poultry production (Gadde *et al.,* 2017).

Cinnamon (*Cinnamomum cassia)* presents a potential alternative. It is non-toxic, residue-free, and offers benefits such as appetite stimulation, increased digestive enzyme secretion, and immune support. Research indicates that cinnamon can improve broiler performance: Toghyani *et al*. (2011) found that 2 g/kg of cinnamon improved body weight, while Ebrahimi *et al.* (2013) observed higher body weights with cinnamon supplementation. Sang Oh *et al.* (2013) reported enhanced meat quality with 3%, 5%, and 7% cinnamon powder in broiler diets. Cinnamon also boosts appetite, digestive enzyme activity, and gut health, enhancing broiler performance and production efficiency (Ali *et al*., 2021; Krauze *et al.,* 2021; Meligy *et al*., 2023; Metwally, 2023; Zawani *et al*., 2022). Dhama *et al.* (2014) noted improvements in digestive enzyme secretion and gut health. This study therefore examined how different levels of cinnamon powder impact the carcass characteristics and gut morphology of broiler chickens.

MATERIALS AND METHODS

The study was conducted at the Poultry Unit of the Directorate of University farms, Federal University of Agriculture, Abeokuta. One hundred and forty (140) one-day old Cobb-500 broiler chicks were purchased from a reputable hatchery and allotted to five treatments with four replicates of 7 birds per replicate raised in a deep litter system in a completely randomized design. The experiment lasted for 49 days. Cinnamon powder was added to the diet at five levels (0, 1.5, 3, 4.5 and 6 g/kg). Water and feed were given *ad-libitum*. Ileal intestinal samples were photographed under using image analysis software and 5 visual fields were observed in each section. The software was used to measure villus height, villus width, crypt depth, crypt width and muscle thickness and the average measurement of each selected photo was used for statistical analysis. Data were analysed using one-way

ANOVA in GLM in MINITAB 18 and significant means ($p<0.05$) were separated using Duncan's Multiple Range Test (Steel *et al*., 1997).

Table 1: Composition of experimental diet

Ingredient	Starter (1-3 weeks)	Finisher (4-7 weeks)
Maize	52.00	54.20
Soybean meal	24.00	25.00
Wheat bran	-	5.70
Groundnut cake	12.84	-
Vegetable oil	2.00	-
Limestone	2.00	3.94
Bonemeal	5.80	9.80
Salt (NaCl)	0.25	0.25
Lysine	0.40	0.20
Methionine	0.36	0.32
Toxin binder	0.1	0.16
Acidifier	-	0.18
*Vit & Min Premix	0.25	0.25
Total	**100.00**	**100.00**
Calculated analysis		
ME (KCal/Kg)	2853.00	3000.00
Crude protein	21.50	20.80
Methionine (%)	0.67	0.67
Calcium (%)	0.63	0.63

RESULTS AND DISCUSSION

Results obtained (Table 2) indicate that all the measured variables were significantly ($p<0.05$) affected by the inclusion of cinnamon powder compared to control diet. Birds fed 6g/kg cinnamon powder recorded highest values for all parameters. Lowest values were obtained in control for villus height and width, likewise in 4.5g/kg for cryptal depth and muscle thickness.

Villi are essential for nutrient absorption as they increase the intestinal surface area. The study found that chickens fed a diet with 6.0g/kg of cinnamon powder exhibited the highest villus height and width. This enhancement translates to a larger surface area for nutrient absorption, which is crucial for the efficient uptake of nutrients. Xu *et al.* (2003) also highlighted the importance of higher villus height for better nutrient absorption in poultry. Similarly, Garcia *et al*. (2007) observed increased villus height in broilers supplemented with formic acid and plant extracts, supporting the findings of this study. It is assumed that an increased villus height is paralleled by an increased digestive and absorptive function of the intestine due to increased absorptive surface area, expression of brush border enzymes, and nutrient transport systems (Pluske *et al*., 1996). It is understood that greater villus height is an indicator that the function of intestinal villi is activated (Yasar and Forbes, 1999; Shamoto and Yamauchi, 2000). This fact suggests that the villus function is activated after feeding of dietary synbiotic or probiotic. Moreover, increased passive absorption of glucose and proline was reported in broiler chickens fed a probiotic containing lactobacilli, *B. thermophilum*, and *E. faecium* (Chichlowski *et al*., 2007).

Table 2: Effects of cinnamon powder on gut morphology parameters of broiler chickens

	INCLUSION LEVEL					
Parameter	**0g/kg**	**1.5g/kg**	**3.0g/kg**	**4.5g/kg**	**6.0g/kg**	**SEM**
Villi height (µm)	0.21^{d}	0.26^{cd}	0.61^{b}	0.33^{c}	0.79^{a}	0.05
Villi width (µm)	0.12^{d}	0.18^{bcs}	0.22^{ab}	0.15^{cd}	0.26^{a}	0.02
Cryptal depth (µm)	0.15^{c}	0.14^{c}	0.23^{b}	0.13^{c}	0.29^{a}	0.02
Cryptal width (µm)	0.14^{d}	0.12^{d}	0.29^{b}	0.22^{c}	0.37^{a}	0.03

Muscle thickness (µm)	0.18[b]	0.19[b]	0.29[a]	0.17[b]	0.29[a]	0.02

[a,b,c,d]: Means with different superscript across the row are significantly (P<0.05) different. *SEM: Standard Error of Mean*

Crypt depth and width are indicators of the regenerative capacity of the gut epithelium. Deeper crypts suggest a higher rate of cellular turnover, necessary for the renewal of villi, particularly in response to inflammation caused by pathogens. This study noted increased cryptal depth and width with the 6.0g/kg cinnamon powder diet, indicating enhanced regenerative capacity. Yason *et al*. (1987) emphasized the importance of crypt depth in maintaining gut health, aligning with our observations.

The study also demonstrated an increase in muscle thickness in the ileum with the 6.0g/kg cinnamon powder diet. Enhanced muscle thickness is indicative of better gut health and functionality, facilitating efficient digestion and nutrient assimilation. This observation is consistent with the general understanding that improved gut structure leads to better overall health and performance in broilers. The positive effects of cinnamon powder on muscle thickness may be attributed to its bioactive components, such as cinnamaldehyde and trans-cinnamaldehyde, which are known to stimulate growth hormone secretion and enhance tissue growth (Sang-Oh *et al*., 2013; Yeh *et al.,* 2013).

CONCLUSION

It can be concluded that the optimum level for optimizing gut morphometry was found to be 6g/kg as it yielded highest values for all measured parameters in the ileum. Cinnamon powder is however recommended to be used as an alternative to antibiotic growth promoter

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