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Performance Indices of Broiler Chickens Fed Graded Levels of Cinnamon in Sokoto, Semi Arid Ecology, Nigeria

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ABSTRACT: This study was conducted to evaluate growth performance and Haematological indices of broiler birds fed with graded level of cinnamon (*Cinnamomun zeylanicum*) in their diets at T1 (300g), T2 (400g), T3 (500g) and T4 (00g)(control) respectively. A total of 200 marshal strain of broiler chicks were randomly divided into (4) treatment groups of 50 birds each. Each treatment was replicated 5 times with ten birds per each replicate, in a Completely Randomized Design setup. Standard management procedures were observed throughout. Data were recorded on feed intake (FI), body weight (BW), body weight gain (BWG) was determined, feed conversion ratio (FCR) was calculated and mortality was recorded as it occurred, the experiment lasted for 8 weeks. Means on the collected data were subjected to Analysis of Variance (ANOVA) and where differences exist, means were separated using the LSD. Results showed that significant difference exists in all the observed performance parameters and optimum performance was achieved in FI (805.77 and 115.08), BW (748.55 and 106.93), BWG (176.49 and 235.21), FCR (0.66) and mortality (6.0%) in treatment 2 (400g Cinnamon) powder inclusion level. It was thus concluded and recommended that Cinnamon powder is beneficial for broiler production and can best be utilized at 400g inclusion level.

Keywords: Broiler birds, growth performance, cinnamon inclusion

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INTRODUCTION

Poultry are domesticated avian species that can be raised for eggs, meat and/or feathers. The term “poultry” covers a wide range of birds, from indigenous and commercial breeds of chickens to ducks, turkeys, guinea fowl, geese, quail, pigeons, ostriches and pheasants. Poultry has become one of the most important animal in Nigeria as it does not only serve as source of meat and eggs, but also plays an important role in the economy of the country. The demand for poultry meat and meat products has increased in recent years. The global production of chicken meat reached about 137 million tons in 2020, making poultry the most consumed meat in the world. Therefore, the poultry industry contributes significantly to animal protein consumption and to human nutrition and global food security (Rashid *et al.,* 2020). In recent years, significant improvements have been made to improve poultry health and performance (Diaz *et al.,* 2019). Previously, antibiotic growth promoters were used to control gastrointestinal pathogens and reduce the effects of stressors on gut function. However, growing consumer awareness about the adverse effects of antibiotics on human health coupled with increased bacterial resistance and concerns about food safety have led to the imposition of restrictions on the use of antibiotics in poultry production. This situation has resulted in researchers and industry exploring alternatives to antibiotic growth promoters (AGPs) with their attention focused on developing more sustainable dietary interventions to improve the gut microbiome and overall health of poultry. Phytogenic feed additives (PFAs) have emerged as alternatives to AGPs and have great potential in the poultry industry (Cottrell *et al.,*

2021). For example, under conditions of heat stress in poultry, they have been shown to improve the immune system, exert positive effects on health performance, and reduce stress response (Yang *et al., 2019;* Saeed, 2020; Rashid *et al.,* 2020). PFA's are plant-derived products which originate from leaves, tuber, or fruits of herbs, spices and other plants which are added to the feed in order to improve performance of animals. They could be used as alternatives to antibiotics. Some of the most commonly used species of PFAs in Nigeria includes *Cinnamomum zeylanicum*, *ginger, garlics, cloves* etc. Using PFAs in poultry nutrition has recently gained increasing interest. Compared to non-AGPs such as organic acids and probiotics that are well established in animal nutrition, phytobiotics are relatively new feed additives. Our knowledge about their modes of action and aspects of application is still rather limited. By adding them to the diet of commercial animals with the aim of improving their productivity through enhancing feed properties, promoting animal's production performance, and improving the quality of products derived from these animals (Windisch *et al*., 2008).

Furthermore, consumers are demanding poultry meat with less fat, and the search for safe growth promotants and carcass modifiers has also become a priority research area. Thus, PFAs have been studied as alternatives to AGPs and growth modifiers to provide safe and wholesome food. Natural antioxidants found in many PFAs have been found effective in extending the shelf life, meat quality and acceptability of poultry meat. Phytochemicals from herbs and spices have attracted particular attention as alternatives to AGPs due to their beneficial properties. Being natural, non-toxic, chemical residue-free and easy availability made them highly acceptable in the poultry industry. Natural products from plants have been found to have beneficial effects viz. appetizer, increased digestive enzymes secretion, immuno-stimulant, bactericidal, antiviral and antioxidants in animals (Ali *et al.,* 2021).

Cinnamon is one of the most potent PFAs, which has great potential for poultry. Therefore, there is a crucial need to review the impacts of cinnamon bioactive compounds on the gut microflora and overall health performance of chicken and develop various effective mitigation strategies to overcome the significant production loss and attain successful production in hot climatic regions or areas (Ali *et al.,* 2021).

Statement of research problem

One of the major problems in Nigeria is the gross deficiency in protein intake, both in quality and in quantity. The best logical solution to the problem of animal protein shortage is to increase the production and consumption of poultry, rabbits and other domesticated monogastric animals and make their products readily available at affordable cost. Incidentally, broiler production in Nigeria is confronted among others with high mortality rate and high cost of broiler feeds and drugs, and these problems demand immediate solution. Although, the use of antibiotics has been known to be efficient by increasing Growth rate by 1-10%, compared to other animals fed without it, it's harmful effect caused as a result of drug residue in the animal body which can lead to drug resistance and other pathogenic defects in the animal and human when infected animals is consumed. Due to the foregoing problems, it becomes penitent that investigations should be carried out to ascertain the efficacy of cinnamon (natural antibiotic) to enhance the growth performance of broiler birds. This study needs to determine various doses and the effects of cinnamon on the growth performance of broiler chickens.

Justification of the study

However, with the introduction of phytogenic feed additives (PFAs) as an alternative to antibiotics, little information in this area about the various doses on broiler birds has been gathered, as well as the effect on the growth performance of the birds. The uses of antibiotics have reduced nutrient loss by improving the nutrient efficiency. However, due to the risk of transferring residues into the animal products, many countries had to place a ban on its use as feed additives (Geidam *et al*., 2009). Hence, forbidding the use of conventional antibiotics as growth promoters, will affect effective feed utilization, and will reduces the chances or an average Nigerian to meet the minimum animal requirements despite the changes in the country's animal species. Despite the good potentials observed in cinnamon's composition, it has not been exploited fully as natural antibiotic in poultry feed and for poultry bird production. There is therefore, the need to investigate it's efficacy at different levels as a phytobiotic feed additive in broiler diets. Thus help in bridging the gap of animal protein problems in the country.

Aim and objectives

The aim of the study therefore, is to evaluate the effects of feeding graded levels of cinnamon powder on the performance indices of finisher broiler chickens in a semi-arid ecology.

MATERIALS AND METHODS

Study area

This study was conducted at the Poultry Production Unit

of the Department of Animal Science, Faculty of Agriculture, Usmanu Danfodiyo University Sokoto, Teaching and Research Farm situated at the Sokoto State Veterinary Centre, along Aliyu Jodi road in Sokoto metropolis. Sokoto State lies between latitude 12º and 13º 04`N and longitude 4º and 6 14`E in the northern part of Nigeria on altitude of 350m above sea level (Mamman *et al.,* 2000). Sokoto metropolis falls in the dry Sahara zone, with an average rainfall of 550mm which start in May or June and ends September/October, minimum and maximum temperature. According to the National Census in NPC, (2006). The population of Sokoto State was estimated at about 3,702,676. The demographic structure of the metropolis is cosmopolitan with the Hausa tribe predominating. Hausa is the most widely spoken language of communication. The state is one of the largest livestock producing areas in Nigeria (SSMIYSC, 2020).

Experimental design

Using Complete Randomized Design (CRD) layout, a total of 200 day-old broiler chicks were divided into four treatments comprising of 50 chicks each. Each treatment was replicated 5 times, with 10 birds in each replicate. Treatment 1, 2, and 3were added 300g, 400g and 500g of cinnamon powder respectively, while Treatment 4 had 0g cinnamon powder and served as the control.

Experimental birds and their management

Sourcing of experimental birds

The one-day-old broiler chicks for this study were obtained from Agrited Farm, Ibadan, Oyo State, Nigeria. The birds were transported to Sokoto overnight in the cool evening hours and reached Sokoto in the cool morning hours of the next day.

Housing and preparation

The bird's house was first cleaned, washed and disinfected a week before the birds arrived. The birds were raised in a deep litter tropical house type, with open side walls and concrete floor. Litter material (wood shavings) was spread on the floor. Feeding rays were used only for 5 days and later replaced with small round conical feeders and small drinkers were used for the first 0-4 weeks (Starter phase), while round conical feeders and plastic semi-automatic drinkers were used at finishing phase (5-7 weeks)

Sourcing and processing of feed ingredients

Feeds ingredients like maize, wheat offal, soya bean meal, bone meal, limestone, cinnamon were obtained and were ground to suitable particle sizes separately at the Sokoto central market. Other synthetic ingredients like premix, salt, vitamins, lysine, and methionine were obtained from their vendor in Sokoto.

Feed/diet formulation

Using a computer software, iso-nitrogenous and iso-caloric diets were formulated for both the starter and the finisher phase for this experiment targeting 3000Kcal/KgME and 21% crude protein for the starter phase and 2800Kcal/KgME and 19% crude protein for the finisher phase respectively (Tables 1 and 2).

Experimental diets

Data collection

Performance

The performance of the broiler chickens was monitored through the feed intake, body weight, body weight gain, feed conversion ratio (FCR), and mortality.

Feed Intake (FI) (g/kg)

Feed given (g or kg) - Feed leftover (g or kg).

Calculated as;

Average feed intake per bird (AFIB) (g)
Average feed intake per bird per day (AFIBD) (g)

Body weight (BW) (g/kg)

Body weight (BW) = Body weight of all birds in each replicate

Calculated as;
Body weight/Bird (BWB) (g)
Body weight/Bird/Day (BWBD) (g)

Body Weight Gain (BWG) (g)

Body Weight Gain (BWG) = Current/Final body Weight - Initial/weight of last week.

Calculated as;
Body Weight Gain per Bird (BWGB) (g)
Body Weight Gain/Bird/Day (BWGBD) (g)

Feed conversion ratio (FCR) (g/kg)

Feed conversion ratio was measured as an index of feed

Table1: Gross and calculated chemical composition of experimental starter and finisher diets.

INGREDIENTS (Kg)	STARTER (2-4weeks) (kg)	FINISHER (5-8 weeks) (kg)
Maize	52.00	51.00
Soya beans meal	14.00	13.50
Groundnut cake	18.00	14.00
Wheat offal	11.00	11.00
Limestone	2.50	5.00
Bone meal	1.30	4.30
Premix	0.25	0.25
Salt	0.25	0.25
Methionine	0.25	0.25
Lysine	0.4	0.40
TOTAL (Kg)	100	100
Calculated chemical composition		
Crude protein (%)	21	19.0
Energy (kcal/kgME)	3001	2803
Methionine (%)	0.6	0.6
Lysine (%)	1.0	1.0
Calcium (%)	1.3	3.0
Phosphorus (avail)	0.5	0.8
Fibre (%) (max)	5.8	6.1

Table 2: Chemical composition of cinnamon *(Cinnamomun zeylanicum).*

Compounds	Concentration (%)
Benzenpropanal	0.19
Cis-cinnamaldehyde	0.98
2-methyl-3-phenyl-propanal	0.30
Trans-cinnamaldehyde	87.32
Cinnamaldehyde dielthyl acetal	2.34
Calamenene	0.35
o-methoxycinnameldehyde	1.88
Alpha-longi pinene	0.24
δ-cadinene	0.45
t-cadinol	0.81
Copaene	0.46
Alpha-cadinol	0.18
Beta-tumerone	3.31
Alpha-bisabolol	0.34
Alpha-tumerone	0.38
Total identified	99.55

utilization

$$\text{FCR} = \frac{feed\ inake}{weig\ ht\ gain}$$

Mortality

A record of mortality was taken as it occurred.

Data analysis

The data was analyzed using General linear model (GLM) procedure of statistical Analysis system (SAS) package Version 9.2 software (SAS, 2007) and the P-value was set at 0.05 level of significance. Where differences exist, least significant Difference (LSD) was used to separate the means.

RESULTS

The result on the general performance of the experimental broiler chicks fed graded levels of Cinnamon powder in the finisher Phase is presented in (Table 3).

Feed intake (FI) performance (g)

Average feed intake per bird (AFIB) (g)

The result on the AFIB performance of the experimental

Table 3: General performance of experimental broiler chickens fed graded levels of cinnamon in the finisher phase (5-8 weeks).

Parameters	Treatment 1 (300g Cinn.)	Treatment 2 (400g Cinn.)	Treatment 3 (500g Cinn.)	Treatment 4 (0g Cinn)	SEM
AFIB	827.75^{c}	805.77^{c}	1981.07^{a}	1855.91^{b}	3.826
AFIBD	118.23^{c}	115.08^{c}	283.01^{a}	265.09^{b}	0.546
BWB	718.01^{ab}	748.55^{a}	670.51^{ab}	654.61^{b}	23.012
BWBD	102.57^{ab}	106.93^{a}	95.78^{ab}	93.51^{b}	3.287
BWGB	218.03^{a}	176.49^{b}	202.75^{ab}	234.13^{a}	8.516
BWGBD	31.14^{a}	25.217^{b}	28.96^{ab}	33.44^{a}	1.216
FCR	0.54^{c}	0.66^{c}	1.39^{a}	1.13^{b}	0.032
Mortality (%)	10.00	6.00	10.00	10.00	-

$^{a-c}$ Mean within the same row with different superscripts are statistically different at P<0.05 ;SEM= Standard Error of Mean, AFIB= Average feed intake per bird, AFIBD= Average feed intake per bird per day, BWB= Body weight s per bird, BWBD= Body weight per bird per day, BWGB= Body weight gain per bird, BWGBD= Body weight gain per bird per day, FCR= Feed conversion ratio.

birds showed a significant difference (P<0.05) between the treatment means. T2 (400g) was observed to have the lowest AFIB (805.77) mean value while T3 (500g) of cinnamon is recorded the highest (1981.07) mean value. T1 and T2 are statistically similar (P>0.05). AFIB from T1 to T3 increased as the level of cinnamon increases except a decline that was observed in T2. Thus, AFIB showed a fluctuating trend with increase in Cinnamon levels across the treatments. On a weekly trend, AFIB increased with the increase in the age of the broiler from week five to week eight. For example, the highest AFIB value (1300.04) is recorded in T2 in week five which has (400g) of cinnamon inclusion while the lowest (1105.30) was observed in T3 with highest cinnamon inclusion in week five. AFIB increase with the increase of cinnamon inclusion except at T3 and T4 (control) where decline or fluctuation occurred. Mean AFIB at the end of four weeks of the finisher phase showed that as inclusion level of cinnamon increase, the mean increase from T1 (300g) to T2 (400g) where a decrease is observed at T3 with highest cinnamon inclusion level (500g) to T4 (0g). T2 recorded the highest mean (2165.17) AFIB. The weekly trend in AFIB is graphically presented in (Figure 1). AFIB result showed that t significant difference (P<0.05) exist between means of treatments. These show that inclusion of cinnamon has affected AFIB significantly. The result contradicts the report of Sani, (2012) who reported that AFTB were not affected significantly (p>0.05) as a result of cinnamon supplementation in the broiler chicken diet.

Average feed intake per bird per day (AFIBD) (g)

The result on the AFIBD performance of the experimental birds is presented in (Table 2). Result on the AFIBD performance shows a significant difference (P<0.05) between the treatment means. T3 was observed to have the lowest AFIBD (115.11) mean value while T3 recorded the highest (40.43) mean value. TI and T2 are statistically similar (P>0.05). AFIB from T1 to T3 decreased as the level of cinnamon increases while increase was seen at T3 with highest cinnamon level and also decline at T4. On weekly basis, AFIBD increased as the birds increase in age from week five to week eight. The lowest (157.92) was in T3 (500g) in week five while the highest (70.74) in T2 week eight. AFIBD increased with the increase of cinnamon inclusion level from T1 to T2 and slightly decline at T3 which has highest cinnamon inclusion (500g) and T4 which served as control. AFIBD mean values at the end of four weeks of the finisher phase fluctuated with increase in the level of cinnamon inclusion. T4 (control) shows the lowest mean value. Weekly trend in AFIBD is graphically presented in (Figure 2). AFIBD result showed that significant difference (P<0.05) exist between means across the treatments. Thus, cinnamon inclusion has an effect on AFIBD at finisher phase. The highest AFIBD was recorded in T3 (500g Cinnamon) while the lowest was observed at T1 (300g Cinnamon). This result contrasts with the reports of George *et al*. (2004), Ali *et al*. (2018), and Homseng *et al.* (2019). These authors reported that cinnamon powder had no effect on the feed intake of poultry birds.

Body weight (BW) performance (g)

Body weight per bird (BWB) (g)

The result on BWB performance of the experimental birds shows is significant difference (P<0.05) exist between the treatment means of birds in T2 (400g Cinnamon) and T4 (00g Cinnamon). Whereas T1 (300g Cinnamon) and T3 (500g Cinnamon) were the same (p>0.05) statistically, Treatment T2 (400g Cinnamon) was seen to have the highest BWB mean value (748.55) while the lowest mean value (654.61) was observed in T4 (00g Cinnamon)

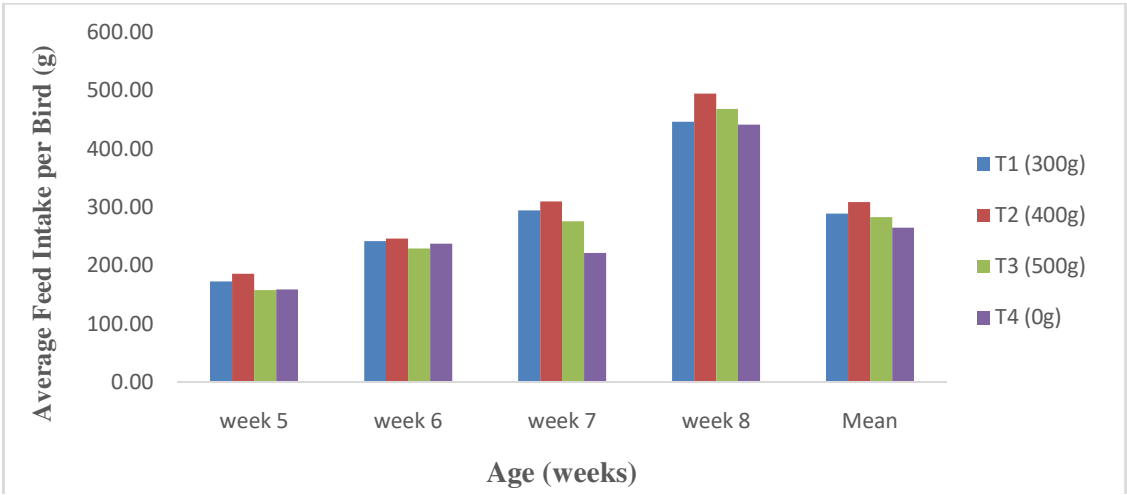

Figure 1: Average Feed intake per bird at finisher phase

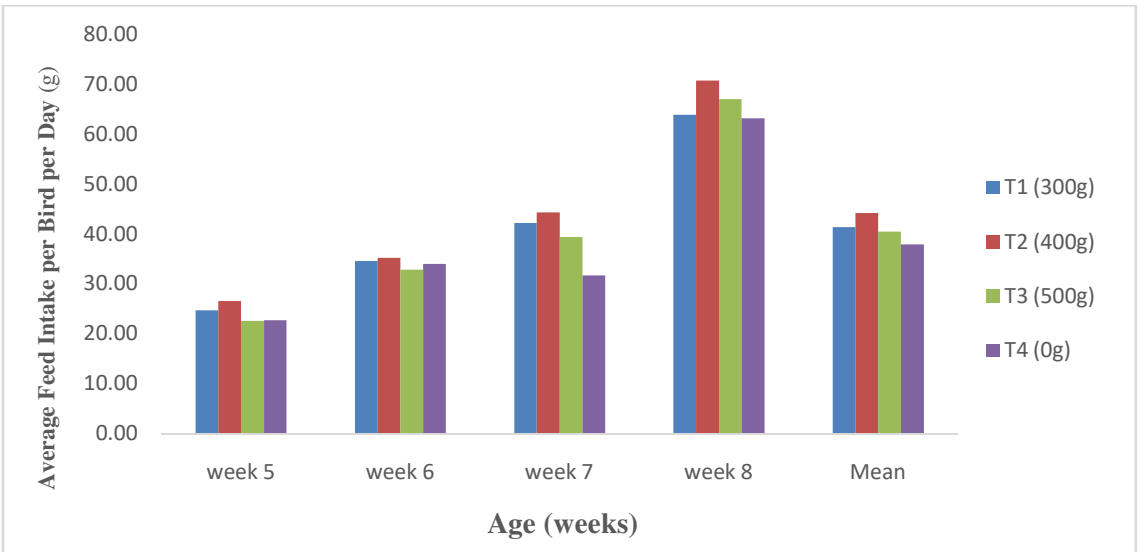

Figure 2: Average feed intake per bird per day

(control). Hence, from T1 (300g Cinnamon) to T3 (500g Cinnamon), BWB values increased with increase in inclusion level of cinnamon but from T3 (500g Cinnamon) showed a slight decline to T4 (00g Cinnamon) (control). The results show that BWB increased with increase in age of the experimental birds from week five to week eight. The lowest BWB (393.09) recorded in T3 week five while the highest BWB (917.32) was recorded at T2 week eight. The BWB means increased as cinnamon inclusion level increased from TI (300g Cinnamon) to T2 (400g Cinnamon) while decrease from T3 (500g Cinnamon) to T4 (00g Cinnamon) (control) was observed. Weekly trend in BWB is graphically presented in (Figure 3). Significant difference ($p<0.05$) existed between the treatment means in this result. The highest was recorded in treatment T2 (400g cinnamon) inclusion. TBW fluctuated with the increase in cinnamon inclusion. Result is in line, with the findings of Al- Sultan (2003) and Kumari *et al.* (2007) who reported that the inclusion of 0.5% turmeric powder significantly increased body weight per birds compared to control in broilers.

Body weight per bird per day (BWBD) (g)

The result on the BWBD performance of the experimental birds showed a significant difference ($P<0.05$) in BWBD means between treatments. The highest BWBD (106.93) mean value was recorded in T2 (400g cinnamon) while the lowest (93.51) was observed in T4 (00g cinnamon) (control). As cinnamon level increases from T1 (300g

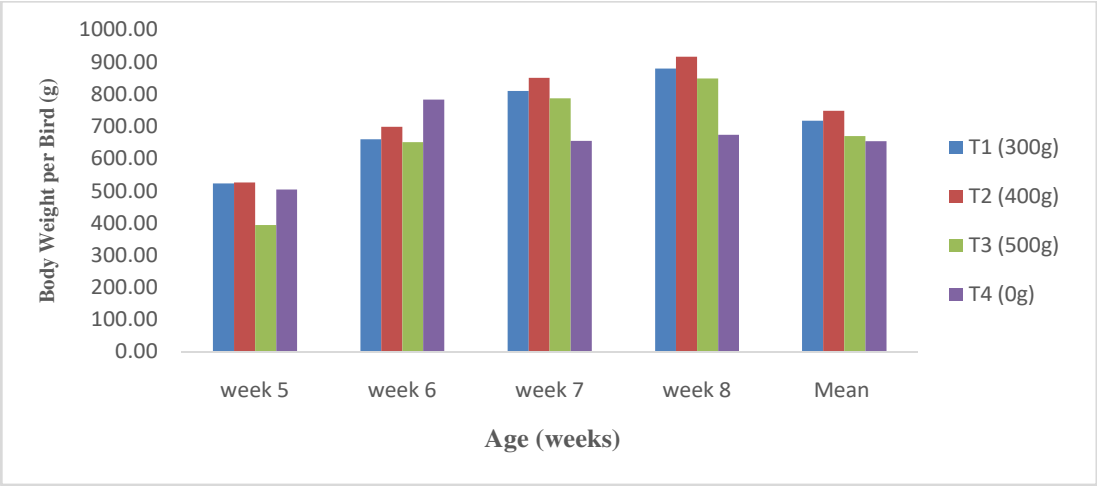

Figure 3: Body weight per bird at finisher phase

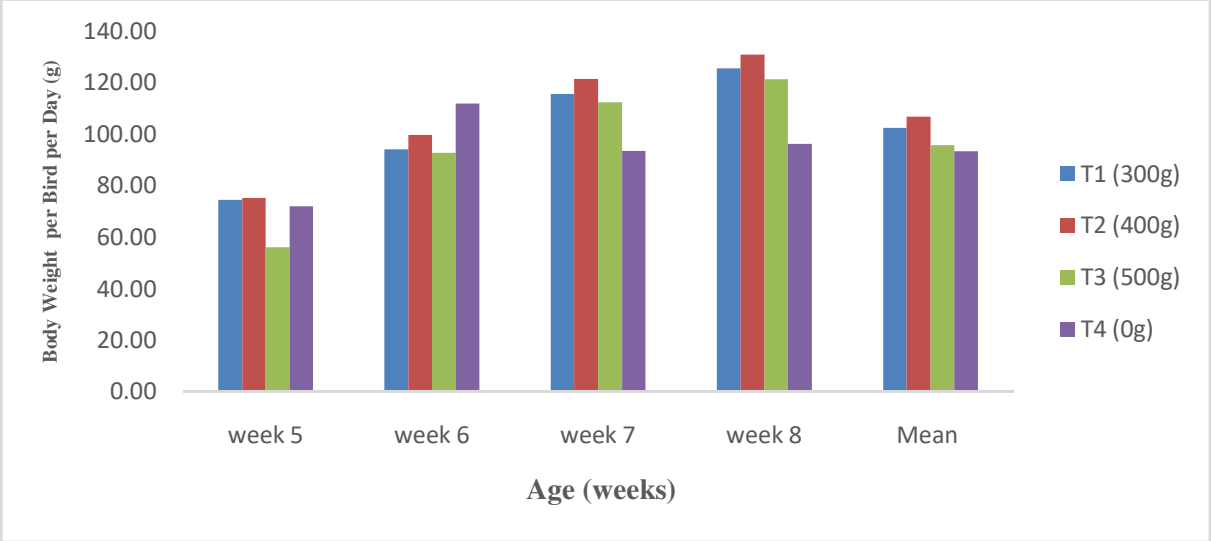

Figure 4: Body weight per bird per day at finisher phase

cinnamon) to T2 (400g cinnamon), BWBD values increased. BWBD value at T3 (500g cinnamon) decreased with the rate of cinnamon inclusion level. BWBD was shown to increase with the increase in the age of the experimental bird from week five to week eight. . The lowest BWBD (56.16) was observed in T3 (500g cinnamon) in week five while the highest (131.05) is recorded in T2 (400g cinnamon) in week eight. A deviation was recorded in the BWBD mean values. For example, as inclusion level of cinnamon increased from T1 (300g cinnamon) to T2 (400g cinnamon), the mean values also increased while it decreased in T3 (500g cinnamon) to T4 (00g cinnamon) (control). The highest BWBD mean (106.94) was recorded in T2 (400g cinnamon) while the lowest (93.52) was recorded in T4 (00g cinnamon) (control). Also, as age of the birds increased BWBD also fluctuate from week five to week eight. The same trend was observed in all the treatments. Weekly trend in BWBD is graphically presented in (Figure 4). Significant difference ($P<0.05$) was reported to exists among the experimental treatments means on BWBD. BWB fluctuated with the increase in cinnamon inclusion among the treatments. However, this study's findings contradicted those of George *et al., (*2004), Sampath and Atapattu (2013) and Homseng *et al.*, (2019). These authors reported that Cinnamon powder has a non-significant effect on body weight of experimental chickens in their researches.

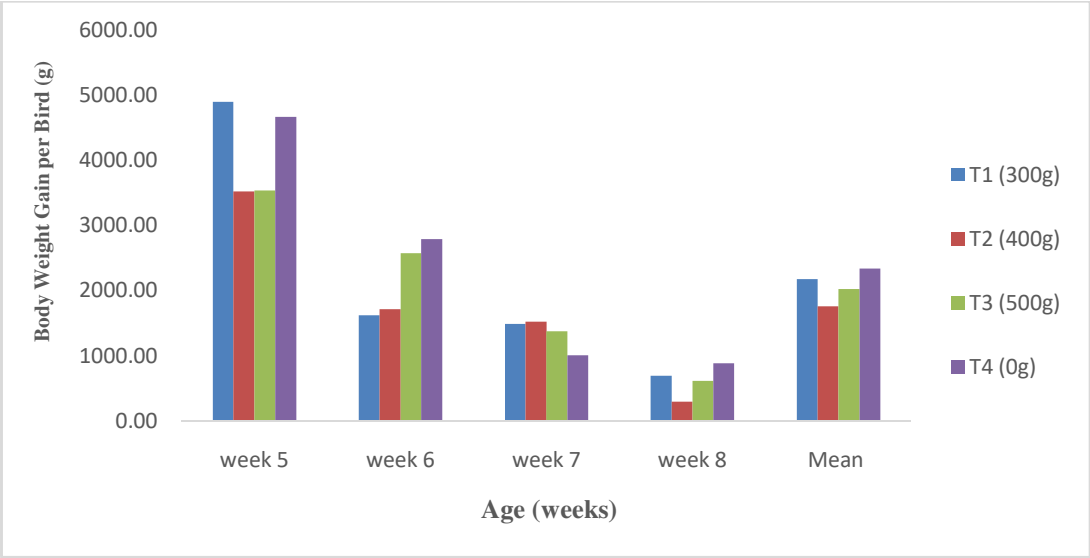

Figure 5: Body weight gain per bird at finsher phase

Body weight gain (BWG) performance (g)

Body weight gain per bird (BWGB) (g)

The result on the BWGB performance showed that significant difference (P<0.05) exist between BWGB means of the experimental birds in all treatments. T4 (00g cinnamon) (control) is recorded the highest (234.135) mean value for BWGB while the lowest (176.49) value was observed in T2 (400g cinnamon). BWGB mean value decreased from T1 (300g cinnamon) to T3 (500g cinnamon) and then subsequently increased at T4 (00g cinnamon) (control). Weekly trend on BWGB showed that BWGB fluctuated across all the treatments with cinnamon inclusion, while it decreased as the experimental birds increase in age from week five to week eight. For example, BWGB decrease with increase in age of the birds from week five to week eight. The highest (4907.04) BWGB was observed in T1 (300g cinnamon) in week five while the lowest (292.01) is recorded at T2 (400g cinnamon) in week eight. Different fluctuation patterns were observed in the other treatments. Mean BWGB values at the end of four weeks of finisher phase showed that BWGB fluctuated as cinnamon inclusion level increased from T1 (300g cinnamon) to T4 control (00g cinnamon) despite all the variations observed in all the treatments. The highest (2341.36) BWGB mean value was observed in T4 (00g cinnamon) (control). Weekly trend BWGB is graphically presented in (Figure 5). Significant difference (p<0.05)) exist between means of among all the treatments at finisher phase. This result is supported by the findings of Turner, (2004) who reported that inclusion of cinnamon has significant (P<0.05) effects on body weight gain per birds. BWGB value are 234.135 of this research is lower than 1737.0 recorded by Samuel, (2019) in a study in Sokoto.

Body weight gain per bird day (BWGBD) (g)

The result on the BWGBD performance showed a significant difference (P<0.05) between the treatment means in all the four treatments. The highest BWGBD mean value (33.447) was seen in T4 (00g cinnamon) (control) while the lowest value (25.21) was observed in T2 (400g cinnamon). BWGBD values fluctuated with increase with increase in the levels of cinnamon from T1 (300g cinnamon) to T3 (500g cinnamon). The BWGBD mean decreased from T1 (300 g cinnamon) to T3 (500 g cinnamon) before slightly increasing again at T4 (00 g cinnamon). Weekly records on BWGBD showed that BWGBD decreased with increase in age of experimental broiler birds from week five to week eight. At the same time an increase was observed across all the treatments as cinnamon inclusion rises. For example, the highest BWGBD (701.01) was recorded in T1 (300g cinnamon) in week five and the lowest (41.72) was recorded at T2 (400g cinnamon) in week eight. BWGBD mean values at the end of four weeks of the finisher phase decreased as the level of cinnamon increased from TI (300g) to T3 (500g) and subsequently slightly increased in T3 (500g cinnamon) to T4 (00g cinnamon) (control). Weekly trend in BWGBD is graphically presented in (Figure 6). There was Significant difference (P<0.05) between TBWGBD means of the experimental treatments. However, this study's findings contradicted with those of George *et al., (*2004), Sampath and Atapattu (2013), Homseng *et al*., (2019). These authors reported that Cinnamon powder

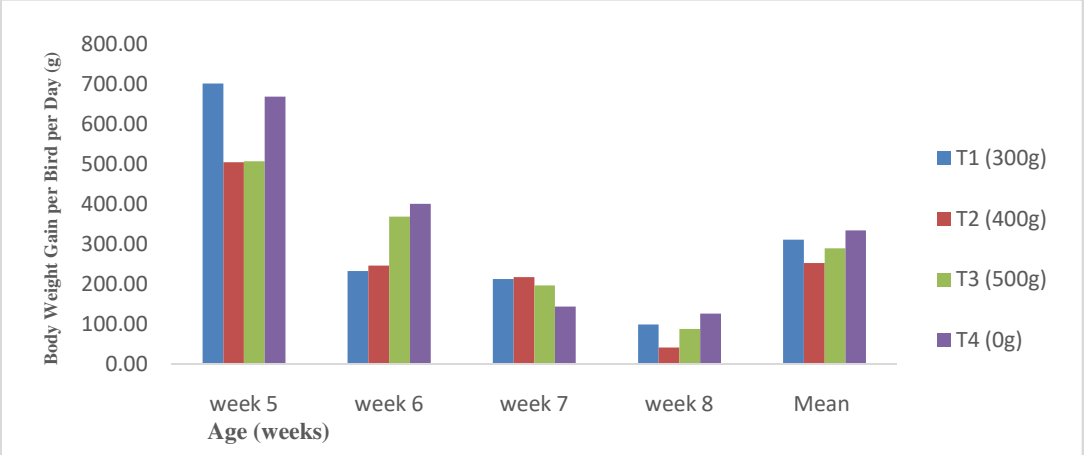

Figure 6: Body weight gain per bird per day at finisher phase

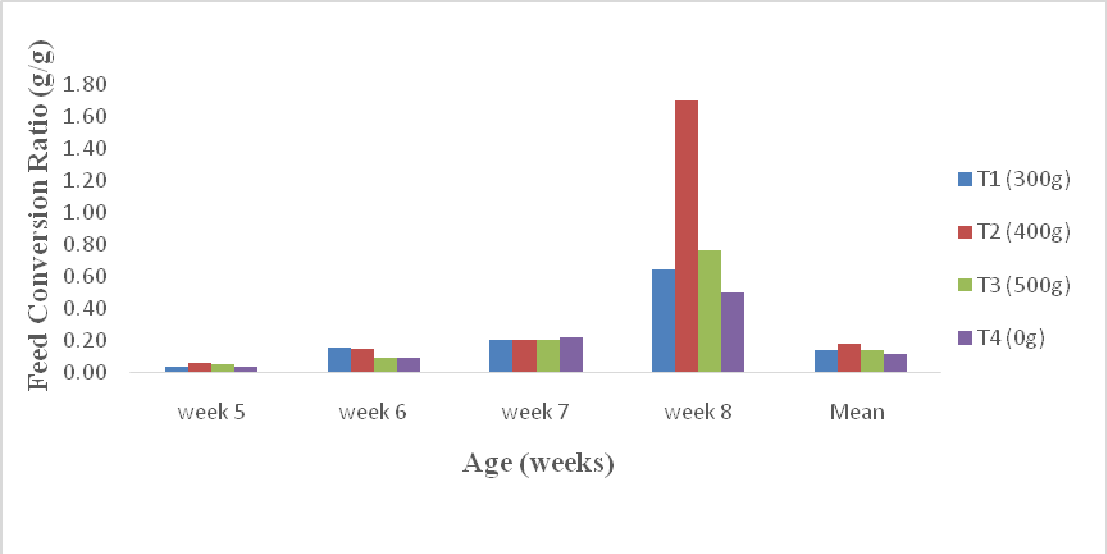

Figure 7: Feed conversion ratio at finisher phase

has a non-significant effect on body weight gain. Also in contrast, was the results of the findings of Nouzarian *et al*., (2011) who reported no substantial change on body weight gain per bird per day of broilers in their trial.

Feed conversion ratio (FCR)(g/g)

Result on the FCR performance of the experimental birds fed graded levels of cinnamon showed THAT significant difference (P<0.05) exist in the FCR mean performance of the experimental birds. The highest (poorest) FCR (1.39) mean value was observed in T3 (500g cinnamon) while the lowest (best) (0.54) is recorded in T1 (300g cinnamon). T1 (300g cinnamon) was seen to be most efficient among the treatments. On weekly basis, FCR increased as the birds increased in age from week five to week eight. FCR was lowest (0.03) in T4 (00g cinnamon) (control) week five whiles the highest (1.70) for T2 (300g cinnamon) in week eight was recorded. The mean FCR values increased and fluctuated as the level of cinnamon inclusion increased from T1 (300g) to T3 (500g). T4 (00g cinnamon) (control) recorded the best FCR while the worst was observed in T2 (400g cinnamon). Weekly trend in FCR is graphically presented in (Figure 7). Significant difference (P<0.05) existed between FCR means among all the treatments. This result contradicts with the finding

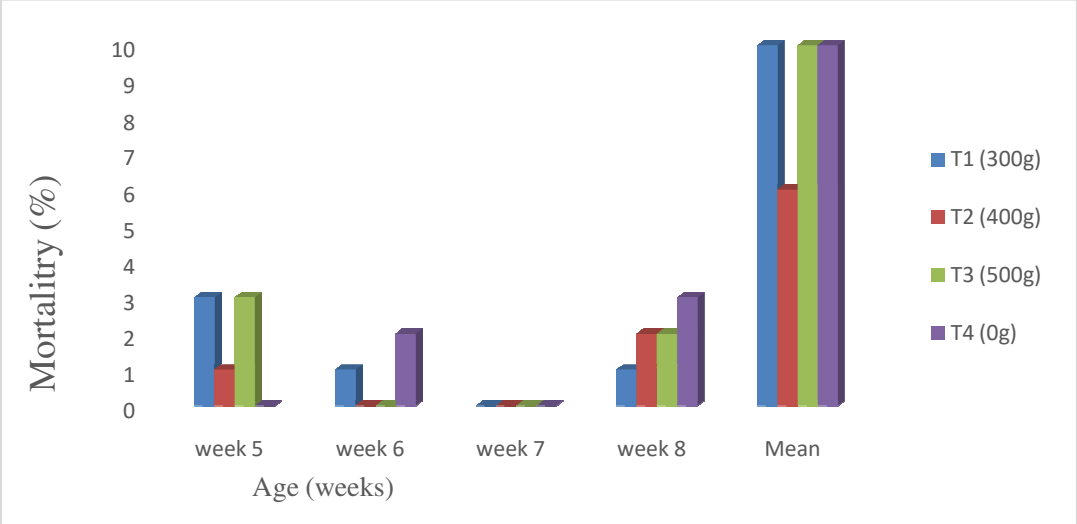

Figure 8: Mortality at finisher phase

of (Fauziyya, 2018) who reported that no significance in FCR when the diets of broiler were supplemented with choline chloride.

Mortality performance

Mortality (%)

Result at the end of the experiment shows mortality of 10% in both treatments 1(300g cinnamon), 3 (400g cinnamon) and 4 (00g cinnamon) respectively. While treatment 2 (400g cinnamon) recorded 6%. T2 with the (400g) of cinnamon recorded the lowest (6%) mortality while highest (10%) mortality was observed in both treatment 1 (300g), 3 (500g) and 4 (00g) (control) respectively at finisher phase. On weekly basis, results showed mortality decreased with increase in the age of the experimental birds from week five to week eight in T1 (300g cinnamon) and T3 (500g cinnamon) across the treatments, while an increase was seen T2 (400g cinnamon) and T4(00g cinnamon). The highest mortality (3) was seen in T1 (300g cinnamon) and T3 (500g cinnamon) in week five respectively, while the lowest (1) was observed in T1 (300g cinnamon) in week eight. Weekly trend in mortality performance is graphically presented in (Figure 8).

Conclusion

Based on the results of the study, it can be concluded that the inclusion of cinnamon in poultry feed as a phytogenic feed additive (PFA) has beneficial effects on the growth performance of broiler chickens. The feed intake was generally lower in treatments T1 and T2 compared to the control treatment (T4), but it was highest in treatment T3 with the highest cinnamon inclusion. Similarly, the body weight results showed higher performance in treatments T1 and T2, although there was a slight decline in treatment T3 compared to the control treatment (T4). The body weight gain indices were better in treatment T1 with the lowest cinnamon inclusion level, but similar to the control treatment (T4). The feed conversion ratio (FCR) was best in treatment T1 and worsened as the cinnamon level increased in the treatments. The mortality rate was lowest in treatment T2, while treatments T1, T3, and T4 all had similar mortality levels. Overall, these findings suggest that incorporating cinnamon as a phytogenic feed additive can improve the growth performance of broiler chickens.

Recommendations

From the research results, it could be recommended that the use cinnamon (*Cinnamomum zeylanicum*) powder as feed additive to enhance the growth performances of broiler chickens. The use cinnamon powder at 400g inclusion level as a PFA in the diets of broiler chickens, owing to superior performance in FI, BW, FCR and mortality records. The use cinnamon powder in broiler feeds in the poultry industry for greater food safety, public health and economic gains. Poultry farmers should be educated on the therapeutic effects and potential of cinnamon (*Cinnamomun zeylanicum*) and other herbal products as cheaper, natural and safe ingredients whose inclusion in the diet of broiler chicken in the poultry

industry would improve chicken health and performance which in turn reduced cost of production and medication.

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