ISSN: 2695-2556 (Online)
ISSN: 2651-5679 (Print)

AKSU Journal of Agriculture and Food Sciences 8(1) 85-95, 2024

https://doi.org/10.61090/aksuja.2024.004

Evaluation of Clove Powder as a Feed Additive on the Performance, Carcass Traits, and Internal Organ Weights of Broiler Chickens

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Abstract

This study investigated clove powder as a feed additive on the performance, carcass traits, and internal organ weights of broiler chickens. A total of 160-day-old (Arbo acre) broiler chickens were utilized for the study. Four diets, designated as T_1, T_2, T_3 and T_4, were formulated. T_1 served as the control with no clove powder, while T_2, T_3 and T_4 had clove powder included at 100 g, 200 g, and 300 g/100 kg of feed, respectively. The birds were distributed into 4 treatment groups, each comprising 4 replicates of ten birds each. Each treatment was randomly assigned one of the treatment diets in a completely randomized design. Significant differences ($P<0.05$) were observed in the final weight, weight gain, and feed intake of the birds at the starter phase. Birds in the T_4 group recorded the highest values ($P<0.05$) for the three parameters assessed. T_1 had the lowest values for the parameters. There was no significant difference in the feed conversion ratio of the birds across treatments. T_4 had the lowest but non-significant feed conversion ratio. In the finisher phase, the result of the performance of the birds followed the same trend. Final weight, weight gain, and feed intake values were observed to be highest ($P<0.05$) in birds fed a T_4-based diet. The feed conversion ratio also indicated no significant ($P>0.05$) difference across treatments. Live weight, dressed weight, dressing percentage, primal cuts (thigh, breast, drumstick, back, and wing) and abdominal fat indicated significant differences ($P<0.05$) across treatments. No significant differences ($P>0.05$) were observed in the internal organs of the chickens. It was concluded that incorporating clove powder up to 300 g in the broiler chicken diet improved growth performance and carcass traits without adverse effects on the internal organs of the chickens.

Keywords: Broiler chicken, Clove powder, Carcass characteristics, Internal organs, Phytogenis

1.0 Introduction

In recent times, the availability of sufficient animal protein to meet the dietary requirement of humans have become a source of global concern especially in developing countries. Meat and eggs from poultry are important sources of dietary protein with high nutritional values. The

consumption of these poultry products has increased greatly thus, exerting pressure on their production (Essien *et al*., 2022a; Essien *et al*., 2023). In livestock production, most especially poultry, employing some strategies in order to achieve maximum productivity is very crucial. Such strategies may involve provision of adequate and high-quality feed and the use of feed additives (Christopher *et al*., 2023; Ekpo and Okon, 2023). For decades, antibiotics have been used as feed additive to promote the growth of poultry. However, its inclusion in animal diet was prohibited by European Union in 2006 due to the emergence of multiple drug resistant bacteria (Belal *et al.*, 2018). Currently, antibiotics are being replaced in poultry feeds by phytogenic compounds from plant materials such as herbs, spices and their essential oils. These compounds are known to possess nutritional and pharmacological properties (Okwu, 2003; Essien *et al*., 2022b). Some herbs and spices used in livestock feeding include *Ocimum gratissimum*, (scent leaf), *Tetrapleura tetraptera*, *Curcuma longa* (turmeric), African nutmeg, selim pepper etc. These plant products are available in different forms; nut, rhizome, leaves, fruit, and bulb (Essien, 2021a; Okon *et al.*, 2023a; Okon *et al.*, 2023b; Okon *et al.*, 2024).

Clove (*Syzygium aromaticum*) is viewed as an imminent and possible alternative to commercial antibiotics. Clove is a native to Maluku Island of Indonesia and is a tree in the family of Mytaceae. It is found in the tropical and sub-tropical lands of Asia, Madagascar, and Africa (Cock and Cheeman, 2018). Clove is a vital source of different essential oil which include eugenyl acetate, caryophylene, and Eugenol which is the most abundant and is produced by different parts of the plant; the flower, bud leaves, and twigs (60-90; 82-88, and 90-95 %) respectively (Barceloux, 2018; Basch *et al*., 2008). Eugenol have been reported to perform a range of bioactivities such as anti-inflammatory, anti-microbial, antioxidant, anti-carcinogenic, anti-diabetic, and anti-ulcer. Clove is also known for its strong aroma and is used in the production of cosmetics and soap. Other compounds found in clove include, vitamin E, vitamin C, flavonoid, tannin, manganese, potassium, calcium, iron, vitamin K and beta-carotene. The chemical composition of clove is revealed to contain, crude fibre (14-37 %), crude protein (6.91 %), crude fat (5.86 %), ash (5.29 %), and soluble sugars (32.10 %), (Kamalpreet *et al.* 2019). Research has explored the utilization of clove in poultry feed (Adebisi et al 2021); however, very little has been done in this regard. Thus, this study was conducted to investigate the effect of graded levels of clove on performance, carcass and internal organ characteristics of broiler chickens.

2.0 Materials and Methods

2.1 Study Location

The experiment was conducted at the Poultry Research Unit of the Department of Animal Science, Akwa Ibom State University, Obio Akpa Campus. The area is situated between latitude $5^{0}17^{1}$N and $5^{0}17^{1}$N and longitude $7^{0}21^{1}$E and $7^{0}58^{1}$E (SLUS-AK, 1994).

2.2 Procurement and Processing of Clove

Dried clove buds (*Syzgium aromaticum*) were purchased from a local market in Abak, Abak Local Government Area of Akwa Ibom State for this study. The dried clove buds were sundried for 2-3 days, ground to powder with the aid of a manual blender (Corona 1016, Landersy Y. CIA South Africa) and stored in plastic bags until it was incorporated in the broilers diet.

2.3 Proximate and Phytochemical Analysis of Clove

Sample of the ground clove buds were subjected to both proximate and phytochemical analysis. The parameters determined in proximate analysis were crude protein, crude fibre,

ether extract and ash according to the method described by AOAC (2000). Phytochemical analysis for some bioactive compounds, tannin, flavonoid, saponin, alkaloids and phenols were determined according to Harborne (1973) and Sofowora (1993).

2.4 Experimental Diet

At both the starter and finisher phases, four diets, designated as T_1, T_2, T_3 and T_4, were formulated. T_1 served as the control with no clove powder, while T_2, T_3 and T_4 had clove powder included at 100 g, 200 g, and 300 g/100 kg of feed, respectively. The formulated diets met the nutrient requirement for poultry as recommended by NRC (1994). Ingredients and nutrient composition of the experimental diets is presented in Tables 2.1 and 2.2.

Table 2.1: Gross Composition of Experimental Broiler Starter Diet

Ingredients	T_1 (0 g CLP)	T_2 (100 g CLP)	T_3 (200 g CLP)	T_4 (300 g CLP)
Maize	50.00	50.00	50.00	50.00
Soya bean meal	28.00	28.00	28.00	28.00
Wheat offal	9.00	9.00	9.00	9.00
Palm kernel cake	5.00	5.00	5.00	5.00
Fish meal	3.00	3.00	3.00	3.00
Bone meal	4.00	4.00	4.00	4.00
Vit/mineral premix*	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Calculated Chemical Composition (% DM)				
Crude protein	23.41	23.41	23.41	23.41
Ether extract	4.07	4.07	4.07	4.07
Crude fibre	3.46	3.46	3.46	3.46
Ash	5.41	5.41	5.41	5.41
Nitrogen free extract	63.68	63.68	63.68	63.68
ME (Mcal/kg)	2879.11	2879.11	2879.11	2879.11

CLP = Clove powder. DM = Dry matter *To provide the following per kg of feed: vitamin A, 10, 000 iv vitamin D_3, 2000 iv: vitamin E, 12 mg: vitamin K, 2 mg: vitamin B_1, 1.5 mg: vitamin B_2, 4 mg: vitamin B_6, 1.5 mg: vitamin B_{12}, 12 mg: Niacin, 15 mg: pantothenic acid, 5 mg: folic acid, 5 mg: biotin, 2 mg: choline chloride, 100 mg: manganese, 75 mg: zinc, 5mg: iron, 2 mg: copper, 5 mg: iodine, 1.0 mg: selenium, 2.0 mg: cobalt 5 mg: anti-oxidant, 125 mg.

2.5 Experimental Bird Management and Layout

A total of 160-day-old (Arbo acre) broiler chickens were utilized for the study. The birds were purchased from a reputable poultry distributor in Uyo, Uyo Local Government Area of Akwa Ibom State. Before the arrival of the birds the house was thoroughly cleaned and disinfected and left for few days. On arrival the birds were weighed to obtain their initial body weight using an electronic kitchen scale (SF – 400). They were thereafter divided into four treatment groups with four replications of 10 birds each. Each treatment was randomly assigned one of the treatment diets in a completely randomized design. Feed and water were supplied ad-libitum. The birds were fed starter diet for four weeks and later changed to finisher diet at five weeks with different inclusion levels of the test ingredient. Routine

management practices were adhered to. Medications and vaccines were administered to the birds appropriately. The experiment lasted for 8 weeks.

Table 2.2: Gross Composition of Experimental Broiler Finisher Diets

Ingredients	T_1 (0 g CLP)	T_2 (100 g CLP)	T_3 (200 g CLP)	T_4 (300 g CLP)
Maize	55.00	55.00	55.00	55.00
Palm kernel cake	4.00	4.00	4.00	4.00
Wheat offal	5.00	5.00	5.00	5.00
Soya bean meal	28.00	28.00	28.00	28.00
Fish meal	3.00	3.00	3.00	3.00
Bone meal	4.00	4.00	4.00	4.00
Lysine	0.25	0.25	0.25	0.25
Vit/Mineral Premix	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Calculated Chemical Composition (%DM)				
Crude protein	21.01	21.01	21.01	21.01
Ether extract	4.33	4.33	4.33	4.33
Crude fibre	4.61	4.61	4.61	4.61
Ash	5.25	5.25	5.25	5.25
Nitrogen free extract	64.81	64.81	64.81	64.81
ME(Mcal/kg	2932.50	2932.50	2932.50	2932.50

CLP = Clove Powder, DM = Dry Matter *To provide the following per kg of feed: vitamin A, 10, 000 iv vitamin D_3, 2000 iv: vitamin E, 12 mg: vitamin K, 2 mg: vitamin B_1, 1.5 mg: vitamin B_2, 4 mg: vitamin B_6, 1.5 mg: vitamin B_{12}, 12 mg: Niacin, 15 mg: pantothenic acid, 5 mg: folic acid, 5 mg: biotin, 2 mg: choline chloride, 100 mg: manganese, 75 mg: zinc, 5mg: iron, 2 mg: copper, 5 mg: iodine, 1.0 mg: selenium, 2.0 mg: cobalt 5 mg: anti-oxidant, 125 mg.

2.6 Data Collection

On a weekly basis, data on body weight gain were collected. Feed intake were obtained by finding the difference between the served feed and left over quantities. The weight gain was calculated by subtracting the initial weight from the final weight. Feed conversion ratio was calculated by dividing the daily feed intake by daily weight gain.

2.7 Carcass Evaluation

At the end of the experiment four birds were selected based on the weight closest to the mean from each treatment and starved overnight of feed. In the morning of the following day, the birds were weighed to obtained their live weight and slaughtered by cutting through their jugular vein and allowed to blend thoroughly. Thereafter the carcasses were scald in hot water for about a minute and defeathered manually. After defeathering the birds were eviscerated and weighed to determine the weight of the carcass. The weight of the primal cut – parts (thigh, breast, drumstick, wing and back) were determined and expressed as percentage of dressed weight while the weight of the organs (heart, liver, kidney and gizzard) was expressed as percentage of live weight. The weight of abdominal fat was also determined.

2.8 Data Analysis

All data collected were subjected to analysis of variance (ANOVA) and significant means were separated using Duncan Multiple Range Test (Duncan, 1955).

3.0 Results and Discussion

The result of the proximate and phytochemical (imposition of clove is presented in Table 3.1. The result revealed that clove contained crude protein (5.13 %), crude fibre (13.35 %), ash (5.57 %), ether extract (4.17 %) moisture (18.13 %) and nitrogen free extract (52.91 %). The result showed that clove is high in fibre, this could be of a great benefit to chickens. Fibre is known for bulkiness; it reduces the intake of excess starchy food. Thus, preventing the occurrence of hypercholesteremia (Ikpeama *et al.*, 2014; Ekpo *et al*., 2022). The value for ash (5.37 %) showed that clove contain a reasonable amount of mineral. Minerals are organic compounds that plays significant role in skeletal structures and connective tissues. They are present in body fluid, plasma and blood cell and in all biological oxidation systems (Aduku, 2004). Their absence in the body may result in structural and physiological abnormalities (Banerjere, 2018).

Clove have been reported to contain a good amount of manganese, calcium, potassium, and iron. Adebisi *et al.* (2021) reported nitrogen free extract and crude protein values of clove as 61.92 % and 5.87 % respectively. The values obtained in the study by Adebisi *et al.* (2021) are slightly higher than those recorded in this study (52.91 % and 5.13 %) for nitrogen free extract and crude protein. The variation could be as a result of differences in soil type, soil nutrient geographical locations and varied environmental conditions (Ekpo and Okon, 2022). The analysis of the phytochemical composition of clove revealed the presence of flavonoid, tannins, phenols, saponin and alkaloids. Some phytochemical compounds are known to possess antimicrobial anti-oxidant, anti-inflammatory, anti-viral and anti-parasitic properties which could be of benefit to animals. However, flavonoid has been reported to inhibit the formation of free fatty acids in the body by scavenging hydroxyl radicals, superoxide unions and lipid peroxyl radicals (Ikpeama *et al*., 2014). Tannins prevent the development of microorganisms by precipitating microbial protein and making nutritional proteins unavailable to them (Prasad *et al.*, 2005). Phenols, help to activate antioxidant enzymes, reduce α-tocopherol radicals, inhibit oxidases and remove free radicals from the body (Oboh, 2007). Saponins are known to exert active antifungal properties. Alkaloids possess anti-bacterial properties.

Table 3.2 presents the result of performance of broiler chickens fed varying levels of clove at the starter growth phase. Result showed significant differences ($P<0.05$) in the final body weight, weight gain and feed intake. Birds in T_4 (300 g) recorded the highest significant values for the two parameters followed by T_3 (200 g), while T_2 (100 g) and T_1 (control), had similar values. The highest significant ($P<0.05$) feed intake value was recorded in T_4 (300 g). While T_1 (control) had the least feed intake values. No significant difference across treatments were observed in the feed conversion ratio of the birds.

At the finisher phase, the result followed the same trend (Table 3.3). Significant differences were observed in the final body weight, weight gain, and feed intake of the birds. Birds fed diets containing varying levels of clove recorded higher significant values over the control. Birds in the T_4 group (300 g) recorded the highest values for final body weight and weight gain. While T_1 control had the lowest values for the two parameters. The increase in the final body weight and weight gains of the broiler chickens fed clove powder could be attributed to

the potential of clove as a spice. Spices have been reported to contain bioactive compounds that play significant roles in the digestion of nutrients.

Table 3.1: Proximate and Phytochemical Composition of Clove Powder (%DM)

Parameter	CLP
Crude protein	5.13
Ash	5.57
Crude fibre	13.35
Ether extract	4.17
Nitrogen free extract	53.65
Dry matter	81.87
Moisture	18.13
Anti-nutrient (mg/100 g)	
Flavonoid	4.21
Phenols	5.33
Tannin	0.43
Saponin	0.031
Alkaloid	0.025

CLP = Clove powder

Table 3.2: Performance of Broiler Chickens Fed Starter Diet Enriched with Different Levels of Clove Powder

Ingredients	T_1 (0 g CLP)	T_2 (100 g CLP)	T_3 (200 g CLP)	T_4 (300 g CLP)	SEM
initial body weight (g)	58.14	58.20	57.81	58.09	0.02
Final body weight (g)	785.38^{d}	791.56^{c}	813.39^{b}	845.56^{a}	1.01
Body weight gain (g)	727.24^{d}	733.36^{c}	755.58^{b}	787.47^{a}	1.03
Daily weight gain(g)	25.97^{c}	26.19^{c}	26.99^{b}	28.12^{a}	0.12
Daily feed intake (g)	58.01^{d}	59.12^{c}	59.51^{b}	60.81^{a}	0.10
Feed conversion ratio	2.23	2.26	2.20	2.15	0.03
Mortality	0.00	0.00	0.00	0.00	

abcd: means across treatments with different superscripts differ significantly ($P<0.05$). CLP = Clove powder

These are known to create an enabling environment in the gut for protein and carbohydrate digestion, enhance the secretion of endogenous digestive enzymes that aid in digestion, and promote absorption and utilization of nutrients (Okwu, 2003; Ingweye *et al.*, 2020) thus, enhancing growth. This result agrees with previous studies by Essien (2021b), Solomon *et al.* (2022), and Okon *et al.* (2023), where broiler birds and rabbits were fed diets containing *Tetrapteura tetratera*, *Xylopia aethiopica,* and *Monodora myristica* and significant increase in final body weight and weight gain values were observed.

The feed intake of the broiler chickens indicated significant differences ($P<0.05$) across treatments. Birds in T_4 (300 g) recorded the highest significant values for feed intake followed by T_3 (200 g) and T_2 (100 g). The lowest value was recorded in T_1 (control). The result showed that feed intake increased with increased levels of clove in the diets. This result revealed the efficacy of clove in improving palatability and feed efficiency in broilers. Starcevic *et al.* (2015) reported that phenols which is one of the bioactive constituents of clove is known to enhance feed intake and feed utilization in broiler chickens. There was no

significant difference (P>0.05) in the feed conversion ratio of the birds at the finisher phase. Birds in T_4 (300 g) recorded the lowest and best feed conversion ratio values. This result showed that nutrients in the feed were effectively utilized and of good quality.

Table 3.3: Performance of Broiler Chickens Fed Finisher Diet Containing Clove Powder at Varying Levels

Ingredients	T_1 (0 g CLP)	T_2 (100 g CLP)	T_3 (200 g CLP)	T_4 (300 g CLP)	SEM
Initial bodyweight (g)	785.38^{d}	791.56^{c}	813.39^{b}	845.56^{a}	0.54
Final bodyweight (g)	2036.67^{d}	2163.33^{c}	2350.00^{b}	2586.67^{a}	1.03
Body weight gain (g)	1251.29^{d}	1371.77^{c}	1536	787.47^{a}	1.21
Daily weight gain(g)	44.69^{d}	48.99^{c}	54.88^{b}	62.18^{a}	0.62
Daily feed intake (g)	110.01^{c}	115.01^{c}	121.01^{b}	130.71^{a}	0.01
Feed conversion ratio	2.46	2.35	2.20	2.10	0.01
Mortality	0.00	0.00	0.00	0.00	

abcd: means in the same row carrying different letter superscript differ significantly (P<0.05). CLP = Clove powder

The result of the carcass characteristics of the broiler chickens (Table 3.4) showed that clove exerted significant impact on live weight, dressed weight, dressing percentages and primal cut-parts (thigh, drumstick, back, breast, and wing) of the birds. Birds in T_4 (300 g) recorded the highest significant value for live weight, dressed weight and dressing percentages. This result could reflect positive relationship between body weight gain and dressed weight where broilers in this study with highest body weight produced heaviest dressed weight. The dressing percentages of broilers chickens in this study were higher than 60.30 – 74.65 % recommended for broiler chickens (Onibi *et al.*, 2009). This result shows a positive impact of clove diets on the birds in promoting the growth of edible parts of the birds. Birds in T_4 (300 g) recorded the highest significant value for dressing percentages. The primal cut parts (breast, thigh, drumstick, wing and back) were significantly (P>0.05) affected by the diets. Birds fed diet containing clove powder recorded higher values of cut parts across treatment. The least and lowest values were observed in the control. The abdominal fat was significantly affected by the diet. There was a significant reduction (P<0.05) in the value of abdominal fat of the birds. The abdominal fat values decreased with increased level of clove in the diet. This could be attributed to the functions of eugenol an essential oil found and extracted from clove. Eugenol is one of the phenolic compounds found in clove. Eugenol is known to exert or possess antioxidant capacity, free radical scavenging activity and inhibiting effect on lipid peroxidation (Kamatou *et al.,* 2012). These findings could confirm the anti-lipidemic and hypolipidemic properties of clove.

The experimental diet had no negative effect on the internal organs (heart, liver, kidney and gizzard) of the birds across treatment. There were no observed abnormalities on the organs. It is assumed that the internal organs of the birds were able to perform their biotransformation functions. Liver and kidney functions in the elimination of toxins and metabolic waste in the body. Normal organ functions observed in this study reflect the absence of toxic substances in the diets. The main function of the heart is circulation of blood to all parts of the body. The normal functioning of the blood observed in this study indicated a perfect distribution of blood containing nutrients to all parts of the body. The normal size of gizzard obtained in this study could reflect the absence of structural component such as hulls, wood shaving, and large cereal particles in the diet (Sacranie, 2017).

Table 3.4: Carcass and Internal Organ Weights of Broiler Chickens Fed Diet Containing Clove Powder

Ingredients	T_1 (0 g CLP)	T_2 (100 g CLP)	T_3 (200 g CLP)	T_4 (300 g CLP)	SEM
Live weight (kg)	2.04^{d}	2.16^{c}	2.35^{b}	2.59^{a}	0.03
Dressed weight (kg)	1.74^{d}	1.86^{c}	2.05^{b}	2.27^{a}	0.12
Dressing percent (%)	85.29^{d}	86.11^{c}	87.23^{b}	87.64^{a}	0.14
Cut- up Part (% DW)					
Breast	16.12^{d}	17.01^{c}	17.31^{b}	18.42^{a}	1.10
Back	8.31^{d}	8.47^{c}	9.24^{b}	10.21^{a}	0.31
Thigh	9.17^{c}	9.56^{c}	10.24^{b}	11.21^{a}	0.12
Drumstick	7.01^{d}	7.36^{c}	8.11^{b}	8.72^{a}	0.01
Wing	4.91^{d}	5.01^{c}	5.63^{b}	5.70^{a}	0.13
Internal Organ Weights (% LW)					
Heart	0.43	0.41	0.43	0.45	0.01
Kidney	0.67	0.68	0.74	0.71	0.03
Gizzard	2.16	2.13	2.17	2.19	0.01
Liver	1.70	1.67	1.73	11.73	0.04
Abdominal fat	0.97	0.65	0.41	0.21	0.31

abcd: means in the same row bearing different letter superscripts differ significantly ($P<0.05$).
DW = Dressed weight, LW = Live weight, CLP = Clove powder.

4.0 Conclusion

The study indicated that supplementing broiler chicken diets with clove powder improves growth performance and carcass traits, particularly when included up to 300 g/100kg of feed.

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