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Effect of Cumin Seed Powder on the Growth Performance, Carcass and Organ Characteristics of Broiler Chickens

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Abstract

This study was carried out to determine the response of broiler chicken to various levels of cumin seed powder as feed additive on performance characteristics. A total of 160 one-day-old chicks were utilized for this investigation. Four diets were compounded for the starter and finisher phases, incorporating cumin seed powder at levels of 0g, 150g, 300g, and 450g per 100kg of feed, labelled as treatment 1, treatment 2, treatment 3, and treatment 4, respectively. The chicks were divided into four groups of 40 birds each and assigned one of the diets in a completely randomized design (CRD). Each group was further subdivided into 4 replicates of ten birds. Feed and water were provided without restriction, and the collected data were subjected to statistical analysis. During the starter phase, significant differences ($P<0.05$) were observed in final body weight, daily weight gain, and feed intake. Treatment 4 exhibited the highest significant values in final weight (1186.56g), daily weight gain (40.32g), and feed intake (1776.60g). Although the feed conversion ratio (FCR) was statistically similar across groups, treatment 4 displayed the lowest FCR (1.56). In the finisher phase, significant differences ($P<0.05$) were again noted in final weight, daily weight gain, and feed intake, with treatment 4 recording the highest values for these parameters (2801.22g, 68.23g, and 134.82g, respectively). While there was no significant difference in FCR among the birds, treatment 4 exhibited the best and lowest FCR. Significant differences ($P<0.05$) were also observed in live weight, dressed weight, and cut parts (breast, thigh, drumstick, back, and wing) percentages. Abdominal fat was significantly affected by the treatment, while no significant impact of the diet was found on the internal organs (liver, heart, kidney, and gizzard) of the birds. It was concluded that incorporating up to 450g of cumin seed powder into the diet of broiler chickens enhanced growth performance and carcass quality without adversely affecting internal organs.

Key words: Cumin seed powder, Carcass, Live weight broiler chickens, Internal organ, Performance

1.0 Introduction

Efficient feed conversion and high productivity are critical expectations for poultry farmers aiming to maintain a profitable business. These objectives can be achieved through various production strategies, including the use of feed additives (Essien *et al*., 2024a). Antibiotic feed additives have traditionally been employed in poultry feed to strengthen intestinal microflora, prevent diseases, and enhance overall poultry performance (Hassan *et al*., 2010).

However, antibiotics have been associated with issues such as cross-drug resistance among pathogens and residues in tissues, which pose significant health risks to humans. These concerns led to the ban of antibiotics by the European Union in livestock feed (EU,-Wide 2005). Consequently, there has been a growing search for natural and safe alternatives with similar antimicrobial and growth-promoting effects to ensure public health safety.

Currently, the use of phytogenic feed additives in poultry feed has garnered significant attention. These natural growth promoters are derived from herbs, spices, and their essential oils (Hassan *et al.,* 2010). They offer substantial benefits to both man and livestock because of their nutritional and medicinal values (Czarra, 2009; Essien, 2021; Okon *et al*., 2022; Solomon *et al*., 2022; Okon *et al*., 2023; Essien *et al*., 2024b). Plants are known to contain antinutritional substances such as trypsin inhibitors, saponins, alkaloid, tannin, phytate, oxalate, polyphenol, flavonoid etc. (Udedibie *et al.,* 2005; Essien and Udedibie, 2007). Phytogenic plants contain various bioactive compounds responsible for diverse physiological functions such as antibacterial, anti-inflammatory, anti-ulcer, antiparasitic, antioxidant, and anti-diabetic effects. In animal nutrition, they aid digestion, enhance the absorption and utilization of nutrients, boost immune status, and improve overall performance (Hassan *et al*., 2010; Okon *et al*., 2024).

Cumin (*Cuminum cyminum* L.) is herbaceous plant with multifunctional characteristics, belonging to the family Apiaceae. Cumin seeds are yellow, brownish, or gray, elongated in shape, and native to Asia, Africa, and Europe (Kubalia, 2019). They are highly valued for their aromatic, medicinal, and nutritional properties and are commonly used as a spice in various cuisines and confectioneries due to their flavor, contributing to a range of commercial food products. Traditionally, cumin seeds have been used to manage ailments such as diarrhea, constipation, jaundice, liver tumors, cough, pain, toothache, flatulence, and epilepsy (Singh *et al.,* 2017).

A study on the chemical profile of cumin seeds by Singh *et al*. (2017) reported that the principal pharmacologically active substance in cumin seed is cuminaldehyde (60%). Other compounds include limonene, ∝- and β-pinene, 1,8-cineole, ∝- and γ-terpinene, safranal, and linalool. Cumin essential oil contains octanol, limonene, thymol, anisyl alcohol, anethole, and vanillin. The nutritional profile of cumin includes protein, cellulose, crude fiber, sugars, and minerals such as iron and zinc (Al-Hashemi, 2014; Johri, 2011). Additional bioactive compounds in cumin seeds include phenolic acids, phenolic diterpenes, and flavonoids, known for their antioxidant and other oxidative activities.

Given the pharmacological and nutritional benefits of cumin seeds, this study aims to determine their effect on the performance, carcass, and organ yield of broiler chickens.

2.0 Materials and Methods

2.1 Experimental Site

The research was conducted at the Teaching and Research Farm of the Department of Animal Science, Faculty of Agriculture, Akwa Ibom State University, Obio Akpa Campus. Obio Akpa is located between latitudes 4°30'N and 5°00'N and longitudes 7°30'E and 8°00'E. The region experiences an average annual temperature of 25°C and relative humidity between 60% and 90%. It is situated within Nigeria's tropical rainforest zone (Akwa Ibom State Government, 2024).

2.2 Source and Processing of the Test Material

Cumin seeds for the research were sourced from the Itu market in Itu Local Government Area. The seeds were then milled into a powder to create cumin seed powder.

2.3 Proximate and Phytochemical Analysis of Cumin Seed Powder

The cumin seed powder was analyzed for proximate composition to determine crude fiber, crude protein, lipid, and ash content, following the guidelines given by AOAC (2005). Phytochemical analysis for tannin, saponin, flavonoid, polyphenols, and alkaloids were conducted using the method described by Harborne (1998).

2.4 Experimental Diets

Four diets were compounded for the starter and finisher phases and labelled as T_1, T_2, T_3, and T_4. Treatment one (T_1), the control, had no cumin seed powder, while T_2, T_3, and T_4 contained 150g, 300g, and 450g of cumin seed powder per 100kg of feed, respectively. The diet composition is detailed in Tables 2.1 and 2.2. The starter diet contained 22.54% crude protein and 2886.49 kcal/100kg of feed and was given to the broilers for the first four weeks. The finisher diet contained 20.61% crude protein and 2987.03 kcal/100kg of feed and was given to the birds from weeks five to eight.

2.5 Management of Experimental Birds and Experiment Layout

A total of 160 day-old Abor Acre chicks were obtained from a reputable chicken distributor in Uyo, Akwa Ibom State. Upon arrival, their initial body weight was measured using a sensitive balance model (SF400). These chicks were then divided into 4 groups of 40 birds each, and each group was assigned to one of four treatment diets in a completely randomized design (CRD). Within each group, further subdivisions were made into four replicates, each containing ten birds. The chicks were housed in deep litter pens and provided with feed and water ad libitum using appropriate drinkers and tray feeders. They received routine vaccinations and medications as per schedule, and strict management practices were adhered to throughout the experiment. The chicks were fed a starter diet from week 1 to 4 and a finisher diet from week 5 to 8. The study spanned a duration of 56 days.

2.6 Data Collection

Weekly recordings of the birds' body weights were conducted. Weight gain was assessed by subtracting the initial weight from the final weight of each bird. Feed intake was quantified by deducting the remaining feed from the previously provided amount each day. The feed conversion ratio was computed by dividing the daily feed intake by the daily weight gain.

2.7 Carcass and Organ Weight Evaluation

Four birds were randomly chosen from each treatment group (one from each replicate) to represent all treatment replicates. These selected birds underwent an overnight fasting period, followed by individual weighing, slaughter, and thorough bleeding. Subsequently, they were scalded in hot water at 54°C for 2 minutes to facilitate manual feather removal. After feather removal, the carcasses were eviscerated following anatomical guidelines from the esophagus to the outlet, as outlined by Fletcher (1999). The weights of the carcass and internal organs (liver, gizzard, heart, and kidney) were recorded and expressed as percentages of live weight. Additionally, various cut parts (thigh, drumstick, wing, breast, and back) were expressed as percentages of dressed weight.

Table 2.1: Ingredients and nutrient composition of starter feed

Ingredients	T_1 (0gCSP)	T_2 (150gCSP)	T_3 (300gCSP)	T_4 (450gCSP)
Yellow maize	50.00	50.00	50.00	50.00
Soyabean meal	28.00	28.00	28.00	28.00
Fish meal	3.00	3.00	3.00	3.00
Palm kernel cake	6.00	6.00	6.00	6.00
Wheat offal	8.00	8.00	8.00	8.00
Bone meal	4.00	4.00	4.00	4.00
Common salt	0.25	0.25	0.25	0.25
Mineral/Vitamin Premix	0.25	0.25	0.25	0.25
L-Lysine	0.25	0.25	0.25	0.25
L-Methionine	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**
Calculated Chemical Composition (%DM)				
Crude Protein	22.54	22.54	22.54	22.54
Ether extract	5.11	5.11	5.11	5.11
Crude fiber	4.31	4.31	4.31	4.31
Ash	3.45	3.45	3.45	3.45
Nitrogen free extract	64.59	64.59	64.59	64.59
ME (Mcal/kg)	2886.49	2886.49	2886.49	2886.49

CSP – Cumin Seed Powder, DM = Dry matter

Table 2.2: Ingredient and Nutrient Composition of Experiment Finisher Feed

Ingredients	T_1 (0gCSP)	T_2 (150gCSP)	T_3 (300gCSP)	T_4 (450gCSP)
Yellow maize	55.00	55.00	55.00	55.00
Soyabean meal	26.00	26.00	26.00	26.00
Fish meal	3.00	3.00	3.00	3.00
Wheat offal	6.00	6.00	6.00	6.00
Palm kernel cake	5.00	5.00	5.00	5.00
Bone meal	4.00	4.00	4.00	4.00
Common salt	0.25	0.25	0.25	0.25
Mineral/Vitamin Premix	0.25	0.25	0.25	0.25
L-Lysine	0.25	0.25	0.250	0.250
L-Methionine	0.25	0.25	0.250	0.250
Total	**100.00**	**100.00**	**100.00**	**100.00**
Calculated Chemical Composition (%Dm)				
Crude Protein	20.67	20.67	20.67	20.67
Ether extract	5.43	5.43	5.43	5.43
Crude fiber	5.31	5.31	5.31	5.31
Ash	4.13	4.13	4.13	4.13
Nitrogen free extract	64.46	64.46	64.46	64.46
ME (Mcal/kg)	2987.03	2987.03	2987.03	2987.03

CSP – Cumin Seed Powder

2.8 Data Analysis

Analysis of variance (ANOVA) was used to analyze all data obtained in this study using the SAS software (SAS, 2002), and significant means were separated using the Duncan's Multiple Range Test.

3.0 Result and Discussion

3.1: Proximate and Phytochemical Composition of Cumin Seed

The proximate and phytochemical composition of cumin seed is detailed in Table 3.1. Proximate analysis serves as an indicator of the nutritive value of food for humans and animal feeds. This type of analysis involves estimating the primary components of foods using methods that allow for quick and reasonably accurate measurements of various food fractions. The proximate composition of cumin seed revealed the presence of crude fiber (11.41%), crude protein (12.43%), ash (8.61%), lipids (7.61%), nitrogen-free extract (46.26%), moisture (13.68%), and dry matter (86.32%). These results indicate that cumin seed contains appreciable amounts of essential nutrients, making it suitable as a feed additive. The low moisture content suggests that cumin seed can be stored for extended periods, as low moisture enhances storage capacity and prolongs shelf-life. The high crude fiber content is noteworthy, as dietary fiber has been reported to reduce the absorption rate of glucose in the bloodstream, hence lowering the hazard of hyperglycemia occurrence (Okeke and Adaku, 2009).

The high ash content indicates that cumin seed is rich in mineral elements. Al-Hashemi *et al.* (2014) reported that cumin seed contains significant amounts of iron and zinc. Iron aids in the utilization of oxygen in the blood and is a component of many enzymes, including cytochromes and flavoproteins. Zinc acts as a co-factor for many enzyme systems and is an essential part of the insulin hormone, which plays a significant role in carbohydrate metabolism (Verma, 2014).

The phytochemical composition of cumin seed showed the presence of flavonoids (5.63%), tannins (1.43%), phenols (4.51%), alkaloids (2.34%), and saponins (1.06%). These bioactive compounds exert nutritional and medicinal functions. Flavonoids possess antioxidant properties and act as free radical scavengers, preventing oxidative cell damage (Okwu and Morah, 2007). Saponins exhibit hypocholesterolemic and anticarcinogenic properties (Koratkar and Rao, 1997). Phenols exhibit anticarcinogenic, anti-inflammatory, cardiovascular, and hepatoprotective activities in animals (Koratkar and Rao, 1997). Alkaloids are known for their analgesic and antibacterial properties and have been exploited as pharmaceutical agents (Madziga *et al.,* 2010). Tannins can bind to proteins and form insoluble complexes, thus reducing protein digestibility (Patra and Saxena, 2010). Variation in the proximate and phytochemical composition of the test diet may be attributed to factors which are not limited to a variety of plants, analytical procedure employed, soil condition of the area for which the crop is planted, and climatic conditions (Ekpo *et al*., 2020).

Table 3.1: Proximate and phytochemical composition of cumin seed powder

Parameters	Composition (% DM)
Moisture	13.68
Dry Matter	86.32
Crude Protein	12.43
Crude Fibre	11.41
Lipids	7.61
Ash	8.61
Nitrogen Free Extracts	46.26
Anti-nutrient	**mg/100g**
Saponin	1.06
Flavonoid	5.63
Phenols	4.51
Tannin	1.43
Alkaloid	2.34

3.2 Growth Performance of Broiler Chickens fed Cumin Seed Powder at the Starter Phase

Performance of the birds during the starter phase is detailed in Table 3.2. Noticeable differences ($P<0.05$) were noted in the final body weight and daily weight gain among the birds. Significantly highest values were observed in treatment 4, followed by T_3, T_2, and T_1. These significant variations suggest an increase in digestive fluid and enzyme secretions, which may accelerate the digestion and absorption processes, thus enhancing growth. This finding is consistent with the report of Essien (2021), where starter broiler chickens fed a diet containing *Tetrapleura tetraptera* showed notable variations ($P<0.05$) in final body weight and daily weight gain.

The values obtained in this study for final body weight are in consonance with those reported by Akpa *et al*. (2010), Alphonsus *et al*. (2012), Ebong *et al*. 2023 and Sam and Okon (2022). This result aligns with the assertions of Essien (2021), who reported that phytogenic plants stimulate digestive enzyme secretions in the pancreas and gut mucosa, as well as increase bile flow, thereby enhancing digestion and improving growth performance.

The diets significantly impacted the feed intake of birds at a starter phase. Feed intake rose with higher levels of cumin seed powder in the diet, suggesting that cumin seed may enhance appetite and feed consumption. T_4 exhibited the lowest FCR, indicating the birds' efficient nutrient utilization from the feed.

3.3 Performance of Broiler Finisher Fed Diet Containing of Cumin Seed Powder

Final body weight and daily weight gain of broiler chicken during finisher phase were similar to what was observed in the starter phase (Table 3.3). Significant variations ($P<0.05$) were noted between the treatments. T_4 recorded had significant final body weight and daily weight gain values, followed by T_3, T_2, and T_1. This implies that higher levels of cumin seed powder have greater growth-promoting effects on broiler chickens compared to lower levels.

Table 3.2: Performance of broiler starters chickens fed diet containing varying level cumin seed powder

Parameters	T_1 (0gCSP)	T_2 (150gCSP)	T_3 (300gCSP)	T_4 (450gCSP)	SEM
Initial Weight (g)	58.34	57.51	58.01	57.66	
Final Body Weight (g)	887.95^{d}	990.97^{c}	1088.78^{b}	1186.56^{a}	1.35
Body Weight gain (g)	829.61^{d}	933.46^{c}	1030.77^{b}	1128.90^{a}	1.43
Daily Weight gain (g)	29.63^{d}	33.34^{c}	36.81^{b}	40.32^{a}	0.45
Total feed intake (g)	1624.28^{d}	1691.48^{c}	1723.96^{b}	1776.60^{a}	0.13
Daily feed intake (g)	58.01^{d}	60.41^{c}	61.57^{b}	63.45^{a}	0.06
Feed conversion ratio	1.95	1.81	1.67	1.57	0.03
Mortality	0.00	0.00	0.00	0.00	0.00

CSP – Cumin Seed Powder; abcd – Means in the same row with different superscripts are different ($P<0.05$).

The improvement in these parameters due to cumin seed powder supplementation could be attributed to the bioactive compounds in cumin seed powder, which may destroy pathogens in the digestive tract. This leads to stabilized intestinal health, creating a conducive environment for effective nutrient digestion and absorption, consequently resulting in improved growth. Cumin seed contains thymol, a colorless crystalline monoterpene phenol known for its pharmacological properties, including antibacterial, antioxidant, antifungal, antiseptic, and antihyperlipidemic activities (Singh *et al.*, 2017). Additionally, several authors have reported the positive effects of phytogenic plants on growth performance, highlighting their ability to modify gut microflora composition and exert beneficial effects on poultry performance (Essien, 2021; Essien and Udoh, 2021).

In another research involving garlic, Odunowo and Olumide (2019) observed significant differences in the final weight gain and daily weight gain of broilers fed garlic as an additive in their finisher diet. The feed consumption of the broilers at the finisher phase was significantly ($P<0.05$) influenced by the diet. T_4 recorded the highest feed intake value, followed by T_3, T_2, and T_1. The variation in feed intake may reflect adequate mineral and vitamin intake, which might have stimulated the birds' appetite, as reflected in the proximate composition results showing that cumin seed powder contains 8.61% ash.

No significant effect ($P<0.05$) was recorded in the feed conversion ratio (FCR) values of the finisher broiler chickens. However, T_4 had the lowest and best FCR. Hassan *et al.* (2010) observed the ability of spices to enhance poultry performance by improving digestive enzyme secretions and reducing pathogenic microbial load, thus making an available favorable environment in the intestinal tract for digestion and effective absorption of nutrients (Okwu, 2003; Ingweye *et al*., 2020).

Table 3.3: Performance of finisher broiler chickens fed diet containing varying levels of cumin seed powder

Parameters	T_1 (0gCSP)	T_2 (150gCSP)	T_3 (300gCSP)	T_4 (450gCSP)	SEM
Initial Weight (g)	892.00	891.03	892.06	890.00	0.01
Final Body Weight (g)	2356.66	2481.00	2673.63	2801.22	1.33
Body Weight gain (g)	1464.66	1589.97	1781.57	1911.12	1.47
Daily Weight gain (g)	52.31	56.78	63.63	68.23	0.51
Total feed intake (g)	3322.76	3533.33	3616.66	3775.00	0.03
Daily feed intake (g)	110.67	126.19	129.17	134.82	0.41
Feed conversion ratio	2.28	2.22	2.03	1.97	0.02
Mortality	0.00	0.00	0.00	0.00	0.00

CSP – Cumin seed powder; abcd – Means in the same row with different superscripts are different ($P<0.05$).

3.4 Carcass and Organ Characteristics of Broiler Chicken Fed Cumin Seed Powder

The carcass parameters examined in this work were significantly ($P<0.05$) influenced by the treatments (Table 3.4). Notable ($P<0.05$) variations were observed in the live weight, dressed weight, and dressing percentage, favoring chickens offered diets supplemented with cumin seed powder. T_4 recorded the highest live weight, dressed weight, and dressing percentage values, followed by T_3 and T_2, which were significantly higher than T_1.

The dressing out percentages of the experimental birds in this study exceeded the 60.30 – 74.65% range recommended for broiler chickens (Bamgbose and Niba, 1998). This suggests that a 450g inclusion of cumin seed powder in the diet of broiler chickens significantly promotes live weight, dressed weight, and dressing out percentages.

Significant differences ($P<0.05$) were also observed in the primal cut-parts (breast, thigh, drumstick, wing, and back). T_4 recorded the highest significant values ($P<0.05$) for wing, back, drumstick, thigh, and breast. This result could be attributed to the phytochemical compounds found in cumin seed, which facilitate efficient protein utilization in the diet, improved protein metabolism, and muscle deposition.

The abdominal fat showed significant differences ($P<0.05$), with T_1 recording the highest significant weight for abdominal fat. This result suggests that cumin seed powder can reduce abdominal fat, thereby bringing down cholesterol and triglyceride levels in the carcass, which may be useful in reducing the risk of heart disease in humans. Flavonoids, phenolic acids, and phenolic diterpenes identified in cumin seed are associated with its antioxidant activity. These compounds play a vital role in preventing lipid peroxidation and different kinds of oxidizing enzymes (Singh *et al*., 2017).

The internal organs showed no notable differences in their means, indicating that cumin seed powder had no negative effect on these organs. This implies that these parts carried out their biotransformation actions effectively.

Table 3.4: Carcass and Organ Weights of Finisher Broilers Chickens Fed Diet Containing Cumin Seed Powder

Parameters	T_1 (0gCSP)	T_2 (150gCSP)	T_3 (300gCSP)	T_4 (450gCSP)	SEM
Live weight (g)	2007.33^{c}	2024.66^{c}	2124.00^{b}	2288.66^{a}	0.62
Dress weight (g)	1533.66^{c}	1552.43^{c}	1676.42^{b}	1845.23^{a}	1.16
Dressing (%)	76.40^{c}	76.68^{c}	78.92^{b}	80.64^{a}	1.34
Cut-Parts					
Breast	30.03^{d}	33.14^{c}	38.51^{b}	40.81^{a}	0.43
Thigh	18.05^{d}	21.22^{c}	24.71^{b}	28.53^{a}	0.21
Drumstick	15.77^{d}	18.91^{c}	22.83^{b}	26.11^{a}	0.33
Wing	11.31^{d}	14.43^{c}	16.38^{b}	19.24^{a}	0.44
Back	17.81^{d}	21.34^{c}	23.48^{b}	25.67^{a}	0.31
Internal Organs (% LW)					
Abdominal fat	2.31^{a}	1.80^{b}	1.13^{c}	0.41^{d}	0.10
Liver	2.46	2.36	2.40	2.47	0.01
Kidney	0.14	0.12	0.14	0.21	0.03
Heart	0.35	0.36	0.33	0.37	0.02
Gizzard	1.91	1.93	1.92	1.94	0.01

CSP – Cumin seed powder

abcd – Means in the same row with different superscripts are different ($p<0.05$).

4.0 Conclusion

This research study demonstrated that the inclusion of cumin seed powder in the diets of broiler chickens had no adverse effects on their growth performance, carcass, or internal organ characteristics. Specifically, the addition of cumin seed powder at levels of 150g, 300g, and 450g per kg of feed resulted in higher final body weights, improved feed intake, and lower feed conversion ratios. Furthermore, it enhanced carcass yield and primal cut parts (thigh, breast, wing, back, and drumstick) of the broiler chickens. Thus, cumin seed powder can be considered a beneficial feed additive for improving the overall performance of broiler chickens.

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