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Effect of Fenugreek Seed Powder as Feed Additive on Growth Performance, Carcass, Organ Characteristics and Nutrient Digestibility of Finisher Broiler Chickens

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Abstract

This study was conducted to determine the effect of varying levels of fenugreek seed powder as feed additive on the growth performance, carcass, internal organ characteristics and nutrient digestibility coefficient of broiler finisher chickens. The experiment utilized a total of one hundred and sixty (160) broiler finisher chickens of Abor Arce breed. Four experimental diets were formulated, incorporating fenugreek seed powder at levels of 0, 100, 200, and 300g per kilogram of feed, labelled T_1, T_2, T_3 and T_4, respectively. The birds were divided into four (4) groups of forty (40) birds each, and each group was assigned one of the diets in a completely randomized design (CRD). Further division within each group resulted in four (4) replicates of ten (10) birds each. Feed and water were provided ad libitum, and the collected data underwent statistical analysis. The duration of the experiment was 28 days. The results indicated notable differences ($p<0.05$) in final weight gain, body weight gain, and feed intake among the birds across the treatments. T_4 demonstrated the highest significant ($p<0.05$) values for feed intake, which increased with the higher levels of fenugreek seed powder in the diet. The feed conversion ratio of the birds remained unaffected by the diet, with T_4 showing the lowest feed conversion ratio. Additionally, the live weight, dressed weight, dressing percentage, and primal cut-parts (thigh, drumstick, back, wing, and breast) were significantly influenced ($p<0.05$) by the diets, with T_4 recording the highest values for these parameters. The internal organs of the birds were not impacted by the diet, while a significant reduction in abdominal fat was observed in T_4. Furthermore, the nutrient digestibility coefficient of the broiler chickens was significantly affected ($p<0.05$) by the diet, with T_4 exhibiting the highest significant nutrient digestibility coefficient value. Hence, it can be concluded that adding fenugreek seed powder to broiler diets at 300g/100kg feed as a feed additive enhances growth performance, carcass internal organ characteristics, and nutrient digestibility coefficient of the birds.

Key words: Performance, Carcass, Internal Organs, Digestibility, Broiler chickens, Proximate composition.

1.0 Introduction

In the last few decades, Antibiotics Growth Promoter (AGP) has been used extensively in poultry production to achieve better performance. Unfortunately, the negative reports associated with its usage which include the development of resistant populations of bacteria, alteration of natural gut microbiota, residues in animal products and effect on human health has resulted in their ban by the European Union in 2006 (EU, 2005).

The use of phytogenic plants and their products as alternatives to antibiotic growth promoters has made a significant impact on poultry production (Essien *et al.*, 2022a). Phytogenic additives, which are natural growth promoters, are derived from herbs, spices, and other plants or their extracts, often in the form of essential oils (Udedibie *et al.*, 2005; Essien and Udedibie, 2007; Windish *et al*., 2008).

These plants contain various bioactive compounds responsible for their diverse biological and pharmacological effects. Some of these plant products act as therapeutic agents and are used in local communities to alleviate different kinds of ailments. More so, their supplementation in poultry nutrition had revealed a huge success. Recent studies showed that phytogenic derivatives, herbs, spice and essential oil supplemented in livestock diet enhance growth performance, digestibility, palatability and efficient absorption of digestible products (Okon *et al*., 2022; Essien and Udoh 2021; Solomon *et al*., 2022; Essien *et al*., 2022; Essien 2021; Okon *et al*., 2023).

Fenugreek (*Trigonella foenum*-graecum) is one of the many phytogenic plants with significant potential. This multifunctional herb belongs to the Fabaceae family and is one of the oldest medicinal plants, known for its exceptional medicinal and nutritional properties. Fenugreek seeds have been reported to contain high levels of protein and total carbohydrates (Bayatizadeh *et al*., 2015), as well as minerals such as calcium, phosphorus, iron, zinc, and magnesium (Gupta *et al.*, 1996). Schryver (2000) reported that fenugreek contains fatty acids mainly linoleic, linolenic, palmitic and oleic, saponin, flavonoid, steroid and alkaloid are also present in fenugreek seeds (Mamoun *et al*., 2014). These bio-active compounds are known for their beneficial impact on digestion, nutrient absorption and growth performance in poultry. Abdul-Rahman (2012) reported significant improvements in packed cell volume, red blood cell count, and haemoglobin levels in broiler chickens fed a diet supplemented with fenugreek seed powder at 10g/kg of feed. Yesuf *et al*. (2017) observed significant differences ($p < 0.05$) in carcass yield and carcass percentage, while Azouz (2001) noted a decrease in total plasma lipid and total cholesterol in broiler chicks. Therefore, this study aims to determine the effects of fenugreek seed powder on the growth performance, carcass yield, and internal organ characteristics of broiler chickens.

2.0 Materials and Methods

2.1 Experimental Site

The study 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 situated between latitudes 4°30'N and 5°00'N and longitudes 7°30'E and 8°00'E. The area is characterized by annual rainfall ranging from 3500 to 5000 mm, an average monthly temperature of 25°C, and relative humidity between 60% and 90%. It is located in the tropical rainforest zone of Nigeria (Akwa Ibom State Government, 2024).

2.2 Source and Processing Method
Fenugreek seeds used in this study were sourced from Itam Market in Uyo Local Government Area, Akwa Ibom State. The seeds were ground into powder using a manual blender (Corona 1016, Lander SY Y. CIA, South Africa).

2.3 Proximate and Phytochemical Analysis of Fenugreek Seed Powder
A sample of fenugreek seed powder underwent proximate analysis to determine its crude protein, lipid, crude fibre, and ash content, following the guidelines provided by AOAC (1995). Phytochemical analysis for tannins, saponins, alkaloids, flavonoids, and polyphenols was conducted using the methods described by Harborne (1973, 1998).

2.4 Experimental Diets
Four broiler finisher experimental diets were formulated and labelled T_1, T_2, T_3 and T_4. Treatment 1 (T_1) served as the control and did not contain fenugreek seed powder, while T_2, T_3 and T_4 included 100g, 200g, and 300g of fenugreek seed powder per 100kg of feed, respectively. The ingredients and nutrient composition of the experimental finisher broiler diets are presented in Table 2.1.

2.5 Management of Experimental Birds and Experimental Layout
A total of 160 Abor Acre day-old broiler chickens were obtained from a reputable poultry distributor in Uyo, Akwa Ibom State, for this study. The birds were brooded together for four weeks and were fed a diet without fenugreek seed powder during this period. At 28 days of age, the birds were weighed and divided into four groups of 40 birds each, with each group assigned one of the treatment diets in a Completely Randomized Design (CRD). Each group was further subdivided into four replicates of 10 birds each, housed in pens measuring 2m by 2m. Feed and water were provided ad libitum using appropriate drinkers and feeders. Routine medications and vaccinations were administered as required. Sanitation practices were rigorously followed, with drinkers washed daily and litter materials changed weekly. The experiment was conducted over a period of 28 days.

2.6 Data Collection
The body weights of the birds were recorded weekly. Weight gain was determined by subtracting the initial weight from the final weight. Feed intake was calculated by subtracting the amount of leftover feed from the amount of feed provided the previous day. The feed conversion ratio (FCR) was calculated by dividing the daily feed intake by the daily weight gain.

2.7 Carcass and Organ Weight Evaluation
At day 56 of the experiment, four birds were selected from each group (one bird per replicate), totalling 16 birds for carcass analysis. These birds were fasted overnight, weighed, slaughtered, and thoroughly cleaned before scalding in hot water. They were then defeathered, eviscerated, and weighed to determine the carcass yield. The weights of the dressed carcass, thigh, drumstick, breast back, wing, shank, and neck were expressed as percentages of the dressed weight. Internal organs such as the gizzard, heart, kidney, and liver were expressed as percentages of the live weight.

2.8 Apparent Nutrient Digestibility Study
At the conclusion of the experimental trial, two birds per replicate from each treatment (totalling 8 birds per treatment) were transferred to metabolic cages equipped with feeding, drinking, and droppings collection facilities. These birds underwent a five-day adaptation

period before commencing the digestibility trial. Collection of droppings was done for the next five (5) days and a quantity of feed was offered to the birds. The droppings were collected in Aluminium foil and oven dried at 60^{o}C for 24hours. The faecal mass of each dropping per day was mixed thoroughly and a representative sample was preserved. The collected droppings were ground, and samples were extracted for proximate analysis in the laboratory. The digestibility coefficient for the proximate compositions was calculated using the procedure of Vogtmann *et al*. (1975).

$$\text{Digestibility coefficient} = \frac{\text{Nutrient in feed} - \text{nutrient in faeces}}{\text{Nutrient in fee}} \times 100 \quad \ldots\ldots\ldots\text{Equation 2.1}$$

2.9 Data Analysis

All collected data were subjected to Analysis of Variance (ANOVA) (SAS, 2002) and significant means were separated using the Duncan Multiple Range Test (Duncan, 1955).

Table 2.1: Ingredient and nutrient composition of broiler finisher diet

Ingredient	T_1 (0gFSP)	T_2 (100gFSP)	T_3 (200gFSP)	T_4 (300gFSP)
Yellow maize	55.00	55.00	55.00	55.00
Soybean meal	28.00	28.00	28.00	28.00
Fish meal	3.00	3.00	3.00	3.00
Wheat offal	5.00	5.00	5.00	5.00
Palm kernel cake	4.00	4.00	4.00	4.00
Bone meal	4.00	4.00	4.00	4.00
Common salt	0.25	0.25	0.25	0.25
Vit/min-premix*	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Total	100	100	100	100
Calculated chemical composition (%DM)				
Crude protein	21.43	21.43	21.43	21.43
Ether extract	4.54	4.54	4.54	4.54
Crude fibre	4.31	4.31	4.31	4.31
Ash	5.13	5.13	5.13	5.13
Nitrogen free extract	64.59	64.59	64.59	64.59
ME (Mcal/kg)	2932.41	2932.41	2932.41	2932.41

FSP – Fennel Seed Powder

*****To provide per kg of feed: Vit A- 1150iu, Vit B_2-1600iu, Riboflavin- 9.9mg, Biotin,-0.2mg; Pantothenic acid-11.0mg; Vitamin K- 3.0mg; Vitamin B_{2-} 2.5mg. Vitamin B_{6-} 0.3mg, Vitamin B12- 8.0mg; Nicotinic acid- 8.0mg, Iron- 5.0mg; Manganese- 10mg; Zinc- 4.5mg; Cobalt- 0.02mg; Selenium- 0.01mg.

3.0 Results and Discussion

3.1 The Proximate and Phytochemical Composition Result of Fenugreek Seed

Table 3.1 displays the proximate and phytochemical composition of fenugreek seed powder. The proximate analysis revealed that the fenugreek seed powder contained moisture (12.10%), crude protein (13.12%), crude fibre (7.15%), ether extract (4.31%), ash (4.80%), and nitrogen-free extract (58.52%). The value of ash and ether extract of this study were close to the value 4.06% and 4.05% reported by Mathur and Chaudhay (2009). The value for moisture was higher than the value 2.5% and 4.25% reported by Audu *et al*. (2002) and

Mathur and Chaudhay (2009). The crude protein value in this research varies with the value (30.82%) obtained by Maha (2021). However, the disparities in the results by the different researchers may be attributed to differences in soil characteristics, environmental conditions of the planting area or cultivation and differences in analytical procedure employed (Ekpo *et al*., 2020).

The phytochemical analysis result revealed the presence of flavonoid, alkaloid, phenols, tannin and saponin. These are plant metabolites with excellent medicinal and nutritional properties. They are known to exert wide range of medical activities such as antioxidant antibacterial, antianorexic, anticarcinogenic, anti-inflammatory, antipyretic, antimicrobial and hypoglycaemic Xue, *et al*., (2007). This result showed that fenugreek seed powder could be used as feed additive to promote growth and also prevent diseases in poultry or broilers.

Table 3.1: Proximate composition of fenugreek seed powder

Parameters	**Composition (%Dm)**
Moisture	12.10
Ether extract	4.31
Crude fibre	7.15
Crude protein	13.12
Ash	4.80
Nitrogen free extract	58.52
Anti-nutrient	
Phenol	3.61
Tannin	1.33
Alkaloid	1.41
Saponin	2.11

3.2 Performance of Broiler Chicken Fed Fenugreek Seed Powder at Varying Levels

The result of the growth performance of broiler chickens fed a diet supplemented with fenugreek seed powder is present in Table 3.2. The current study showed a significant ($p<0.05$) impact of the diet on final body weight and body weight gain of the birds. T_4 recorded the highest significant values ($p<0.05$) across treatments followed by T_3 which was significantly higher than T_2 and T_1. T_1 had the lowest value for final body weight and body weight gain. The increase in body weight was observed as the level of fenugreek seed powder increased in the diet. This may be linked to the beneficial effect of fenugreek seed as spice. Spices are known to stimulate appetite and enhance the secretion of digestive enzymes that boost the digestion of protein, carbohydrates and absorption of these digestive products thus, resulting in better growth performance (Okwu, 2003; Ingweye *et al.* (2020).

Furthermore, fenugreek seed has been found to contain essential fatty acids and high-quality protein (Zuk-Crolaszewska and Wierzbowska, 2017), and it has been reported to stimulate the villus height of the digestive system (Mamouon *et al*., 2014). These results align with the findings of Kumar *et al*. (2021) and El-Ghamy *et al.* (2024), who observed a significant improvement in body weight gain and final weight gain of broiler chickens with the addition of fenugreek seed powder. The feed intake of broiler chickens showed significant differences ($P<0.05$) across treatment groups, increasing as the level of fenugreek seed powder in the diet increased. The values obtained in the final body weight were similar to the reports of Sam and Okon (2022). There was a significant difference ($P<0.05$) in feed intake between treatment groups, with T_4 recording the highest significant ($P<0.05$) feed intake value. The positive impact of fenugreek seed powder on feed intake could be assessed in a different

perspective: fenugreek seed is a spice and spices are known to have strong and distinct aroma which can improve palatability in feeds thus improving or enhancing feed intake. Additionally, fenugreek seed has been reported to contain neurine, biotin and trimethylamine which helps to stimulate appetite through their action on the nervous system (Alloui *et al.*, 2012). The findings are consistent with the studies by Ali *et al.* (2021), Kumar *et al*. (2021), and Mamoun *et al.* (2014), where broiler chickens fed diets supplemented with fenugreek seed powder showed a significant increase in feed intake. However, there was no significant change in the feed conversion ratio of the birds, with T_4 exhibiting the lowest feed conversion ratio. These results indicate effective utilization of nutrients in the feed. The study also revealed improved digestibility and efficient absorption and utilization of nutrients in the birds' diets with the supplementation of fenugreek seed powder.

Table 3.2: Growth performance of finisher broiler chickens fed diet containing fenugreek seed powder

Parameter	T1 (0gFSP)	T2 (100gFSP)	T3 (200gFSP)	T4 (300gFSP)	SEM
Initial weight (g)	880.62	881.72	882.32	880.78	0.01
Final weight (g)	2326.33^{d}	2481.66^{c}	2692.33^{b}	2790.33^{a}	0.43
Daily weight gain (g)	51.63^{d}	57.14^{c}	64.64^{b}	68.19^{a}	0.04
Total feed intake (g)	3475.08^{d}	3582.04^{c}	3688.16^{b}	3794.00^{a}	0.46
Daily feed intake (g)	124.11^{d}	127.93^{c}	131.72^{b}	135.50^{a}	0.19
Feed conversion ratio	2.40	2.23	2.03	1.97	0.02
Mortality	0.00	0.00	0.00	0.00	0.00

FSP – fenugreek seed powder, abcd – means on the same row bearing varying superscripts differ significantly ($P<0.05$)

3.3 Carcass and Body Component of the Broiler Chickens Fed Varying Levels of Fenugreek Seed Powder

The diet significantly ($P<0.05$) influenced the carcass and body components of the broiler chickens across all treatments, as shown in Table 3.3. Live weight, dressed weight, dressing percentage, and primal cut parts (wing, thigh, drumstick, back, and breast) varied significantly among treatments. The highest values for the afore-mentioned parameters were observed in T_4 while T_1 recorded the lowest. Each treatment differs significantly from each other. This result revealed an efficient feed utilization by the birds which resulted in a better muscle deposition by birds fed fenugreek seed powder. Abbas (2010) noted a notable rise in the dressed weight of birds given diets supplemented with fenugreek seed powder at 1% and 2% levels, respectively.

The dressing percentage of the birds in this study exceeded the recommended range of 60.30% to 74.65% for broiler chickens (Onibi *et al*., 2009). Similar findings were reported by Mamoun *et al*. (2014) and Toaha *et al.* (2016), who observed significant enhancements in the dressing percentage of birds fed diets containing 1% and 2% fennel seed powder.

Significant differences were noted among treatments in the cut-parts (breast, back, wing, thigh, and drumstick) of the birds. The findings indicated an increase in the weight of the thigh, breast, back, wing, and drumstick of the slaughtered birds. T_4 exhibited the highest significant weight among all the cut-parts evaluated.

Significant difference ($P<0.05$) was observed in the abdominal fat of the birds across treatment. T_4 indicated or recorded the lowest abdominal fat values. This result revealed that

the abdominal fat of the broiler chickens reduced significantly with increasing levels of fenugreek seed powder. The declining values of abdominal fat observed in this study with increasing levels of fenugreek seed powder suggest strong fat-reducing properties of the seed due to the presence of antioxidants and flavonoid which help to inhibit lipid peroxidation or lipid oxidation rate.

The internal organs (heart, kidney, gizzard and liver) were not affected by the diets across treatment. This could reveal that the birds were able to perform their normal biotransformation functions.

Table 3.3: Carcass and internal organ characteristics of broiler finisher chickens fed diet containing fenugreek seed powder

Parameters	T_1 (0gFSP)	T_2 (100gFSP)	T_3 (200gFSP)	T_4 (300gFSP)	SEM
Live weight (g)	2326.33	2481.66	2692.33	2790.33	1.34
Dressed weight (g)	1774.76^{d}	1928.08^{b}	2160.89^{b}	2305.77^{a}	1.41
Dressing Percent %	76.29^{d}	77.69^{c}	80.26^{b}	82.63^{a}	1.05
Primal Cut-Parts (% DW)					
Breast	30.21^{d}	34.41^{c}	37.32^{b}	40.51^{a}	0.14
Back	23.11^{d}	25.32^{c}	27.41^{b}	29.33^{a}	0.02
Thigh	19.09^{d}	22.54^{c}	26.33^{d}	30.41^{a}	0.13
Drumstick	20.71^{d}	23.11^{c}	25.76^{c}	29.62^{b}	0.15
Wing	14.29^{d}	17.41^{c}	20.43^{b}	25.11^{a}	0.12
Internal organ (% LW)					
Liver	2.28	2.22	2.28	2.30	0.03
Kidney	0.13	0.15	0.14	0.18	0.01
Gizzard	1.55	1.59	1.56	1.60	0.01
Heart	0.33	0.34	0.36	0.38	0.02
Abdominal fat	2.16^{a}	1.20^{b}	1.13^{c}	0.43^{d}	0.03

abcd – means on the same row with different superscript are significantly different ($p<0.05$), FSP – Fenugreek Seed Powder, SEM – Standard Error of Mean, DW-Dress weight, LW-Liveweight

3.4 Nutrient Digestibility Coefficients of the Broiler Chickens Fed Varying Levels of Fenugreek Seed Powder

Table 3.4 presents the nutrient digestibility coefficients of the broiler chickens fed varying levels of Fenugreek Seed Powder. The findings indicate enhanced nutrient utilization in birds fed diet supplemented with fenugreek seed powder. Significant differences ($P<0.05$) were observed in the digestibility coefficients of crude protein, crude fibre, ash, and ether extract compositions. T_4 exhibited the highest digestibility coefficient, followed by T_3, T_2 and T_1, with notable differences ($P<0.05$) between treatments. Digestibility is an important aspect of animal nutrition, as digestibility of ingested materials has direct relationship with growth. The result of nutrient digestibility coefficient of birds in this research could be link to the report of Zhang *et al*., (2009); Greathead (2003) who observed that spices and herbs and their essential oil are known to improve digestion, enhanced digestive enzymes secretions and utilization of the digestive products. While Kumar *et al*., (2021) suggested that herbs, spices, and plant extracts can stimulate appetite and digestion, this study demonstrated excellent feed utilization by the birds.

Table 3.4: Nutrient Digestibility coefficient of broiler finisher chickens fed Fenugreek seed powder

Parameter %	T_1	T_2	T_3	T_4	SEM
Crude protein	72.84^{d}	80.81^{c}	84.32^{b}	86.88^{a}	1.04
Crude fibre	70.11^{d}	73.41^{c}	75.53^{b}	78.61^{a}	1.01
Ash	81.33^{d}	83.43^{c}	85.61^{b}	87.88^{a}	0.13
Ether extract	68.71^{d}	70.55^{c}	74.81^{b}	78.55^{a}	0.07
Nitrogen free extract	70.43^{d}	75.48^{c}	77.64^{b}	81.43^{a}	0.04

abcd – means within the same row with different superscript differ significantly, SEM – Standard Error of Mean, FSP – Fennel Seed Powder

4.0 Conclusion

The study revealed that addition of fenugreek seed powder up to 300g/kg can serve as an alternative feed additive in broiler diet to enhance growth performance, carcass, internal organ characteristics and nutrient digestibility coefficient of the birds.

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